INTEGRATED EDITION OF THE PETROLEUM ENGINEER

the Petroleum Engineer
FOR MANAGEMENT

JUNE 1960
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ACTIVITIES IN OIL AND GAS ROUND THE WORLD

Pipeliners Find Small Turbines Useful
Research Managers Eye Production Costs
Petrochemical Output Jumps in Brazil

HOW MANY PROGRESSIVE IDEAS CAN YOU SPOT AT THIS DOWELL FRAC JOB?

Fracturing has come a long way in the past 10 years. And new ideas continue to improve this method of well stimulation. Pictured above are just four of the contributions Dowell has made to help you get more oil through better fracturing. *Allison aircraft engine-powered pumpers*—compact, powerful. *Remote control panels*—for safer, exacting control of the job. At the well, the special *frac header*—for more safety, efficiency. The new *radio helmets*—for even better control of the job. Not shown, but also important: *Abrasijet,** abrasive perforating service—to reduce breakdown pressures; and the *"Frac Guide"** —for really precise engineering of treatments. New ideas . . . more for your money . . . *dial Dowell.* Dowell, Tulsa 1, Okla.

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the three-legged stool

Publishing is often compared to a three-legged stool; the three legs representing editorial, circulation, and advertising. A strong editorial product, well conceived and properly presented, attracts strong readership (circulation). Obviously, this type of audience by a publication affords an effective vehicle for the advertiser.

The very successful and wonderfully entertaining New Yorker magazine states its code of publishing practices: "No great magazine has ever been conceived as a great advertising medium. Every great magazine has been conceived as a publication for the reader. As it takes care of the reader in the best of all possible ways, the advertising is certain to follow."

Our code is somewhat similar, but more briefly stated, our editors are instructed to always ask themselves, "What's in it for the reader?"

Here at PE headquarters, you — the reader — are the key to our entire publishing operation. Your acceptance or rejection of the editorial material presented determines our position on the ladder of success.

How do we live up to our publishing code? Actually it isn't easy. There are five yardsticks which we rigidly adhere to in living up to "What's in it for the reader?"

1. Will it help YOU make a decision?
2. Will it help improve YOUR operation?
3. Will it help prepare YOU for promotion/advancement?
4. Will it broaden YOUR job understanding?
5. Is this material of such high general interest to be helpful to at least 50% of our total readership?

To produce over 900 editorial pages in our family of five oil and gas publications during the first five months of 1960, our editors were really on the move. A quick look at the record reveals that, to produce the material for these pages meeting "What's in it for the reader?" standards, members of the editorial staff travelled over 60,000 miles on field and plant trips, and in attendance of industry meetings. They attended 118 meetings, made personal talks or presentations before five of them, and evaluated a total of 870 manuscripts. (This includes papers presented before meetings, articles, both solicited and unsolicited.) That's a lot of travel, hand-shaking, talking, and writing. Thought you might be interested in how we do it.

Have you ever thought of writing? Are you nursing an idea that may be worthy of publication? If so, send it along and we will apply the five yardsticks listed above.

Joe B. Thoolen

Publisher

THE PETROLEUM Engineer

FOR MANAGEMENT

NUMBER 6 • VOLUME XXXII • JUNE, 1960

World-Wide Competition Sharpens Oil Paradox A-21

Petroleum activities in 125 countries and areas are reviewed in this 13th annual survey. — *Ernestine Adams*

Aden, Afghanistan, Alaska, Angola, Algeria/Sahara, Albania, Argentina, Australia, Austria.

Bahamas, Bahrain, Barbados, Belgian Congo, Belgium, Bolivia, Brazil, British Borneo, British Guiana, British Honduras, Bulgaria, Burma.

Cameroun, Canada, Ceylon, Chile, Chinese People's Republic, Colombia, Costa Rica, Cuba, Cyprus, Czechoslovakia.

Denmark, Dominican Republic.

Ecuador, Egypt, El Salvador, Ethiopia.

Finland, Formosa, France, French Equatorial Africa, French West Africa.

Gambia, Germany (East), Germany (West), Ghana, Greece, Guatemala.

Haiti, Hawaii, Honduras, Hungary.

India, Indonesia, Iran, Iraq, Ireland, Israel, Italy.

Jamaica, Japan, Jordan.

Kenya, Kuwait.

Laos, Lebanon, Libya.

Madagascar, Malaya-Singapore, Malta, Mexico, Mongolia, Morocco, Mozambique.

Netherlands, Netherlands Antilles, Neutral Zone (Kuwait-Saudi Arabia), New Caledonia, New Guinea, New Zealand, Nicaragua, Nigeria, Norway.

Oman-Muscat-Dhofar.

Pakistan, Panama, Papua, Paraguay, Peru, Philippines, Poland, Portugal, Portuguese Guine, Puerto Rico.

Qatar.

Romania.

Saudia Arabia, Somalia, Somaliland, Spain, Spanish Guinea, Spanish Sahara, Sudan, Sweden, Switzerland, Syria.

Tanganyika, Thailand, Timor, Trinidad, Trucial Coast, Tunisia, Turkey, Turks Island.

Union of South Africa, United Kingdom, United States, Uruguay, USSR.

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Here's a check list that may save you trouble and cut down on turnover — it adds up to a barrier for people you shouldn't hire. — *Ernest W. Fair*

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Highlights and footnotes

Enters Plastics Market. With the opening of the Humble polypropylene unit in Baytown, Texas, Jersey Standard launched into the plastics business. The 40-million-pound a year capacity makes it by far the largest producer of polypropylene in the field.

World Congress. Frankfurt-On-Main, West Germany, has been selected as the location for the Sixth World Petroleum Congress in 1963. Although no date has yet been announced, an office has been opened at Lange Reihe 14, Hamburg 1, under the management of Dr. Curt Weber. Last meeting was in May 1959 in New York.

Soviet Economic Threat. Don't forget the economic competition between Socialists and Capitalists while the spotlight's on politics. Greater America, Inc., formed by top U. S. industrialists, aims to awaken Americans to Russian economic danger. Oil trades are one battle in the war. (See Page A-21.)

Zoom! Estimates indicate these rises for 1976, U. S. Department of Commerce reveals: 37% increase in population over 1956; 75% increase in motor vehicles; 93% increase in travel, and 94% increase in motor-fuel consumption. This means average vehicle will travel 10,562 miles in 1976, consuming 855 gal of fuel. Sounds good from here.

Award for Education Funds. The Esso Education Foundation received the Alpha Kappa Psi Foundation's annual award for distinguished service to higher education. The bronze tablet was presented to David A. Shepard, executive vice president of Jersey Standard by Dr. Joseph H. Taggart, New York University. Jersey Standard was a company that went to court and won the right to devote some company funds to education many years ago.

When Was That? Maybe our memory serves us poorly, but it seems that not very long ago there were a number of great authorities in the United States who said that within a short time the Atomic Power Plant business would make oil and gas obsolete. In 1954, the government allowed private concerns to enter the field, but atomic energy is guarded by an economics dragon, which has slowed new nuclear reactors down to one in 1959.

Harassing Tactics Upheld. The U.S. Supreme Court ruled that unions could use harassing tactics to force employers to give in to bargaining demands without actually going out on strike. On the other hand, an employer must either close down his business or pay employees while they disrupt his operations. This is just another weight on the wrong side of the balance between management and labor negotiations.

Clark to Buy Intex. Negotiations by which Clark Oil and Refining will acquire all the assets of Intex in exchange for common and preferred stock have been completed. Clark is a leading independent refiner and marketer with headquarters in Milwaukee. Intex (Bakersfield, California) is an independent exploration and production company.

Factory For Peru. The first oil field supply firm to begin manufacturing in Brazil is Precision Manufacturing Company owned by Mission Manufacturing, Houston, and Brazilian interests. The company will begin by making mud-pump fluid-end parts. Although a private venture, its customer will be Petrobras, Brazilian government's oil monopoly.

Favors Nationals. In revised regulations for oil and gas leases in the Yukon and Northwest Territories, the Canadian Government has emphasized Canadian residence. A lease is granted only if the Minister of Northern Affairs is satisfied the applicant is a Canadian citizen or if a company is a least half owned by nationals.

Employee Work Costs. U. S. Steel in its annual report shows wide difference between average hour wage, $2.43 and cost of hour's work to company, $4. The difference is made up by overtime, vacations, holidays, pensions, insurance, social security, etc. It's time all companies figured work costs. Most employees have no idea what their benefits cost the company.

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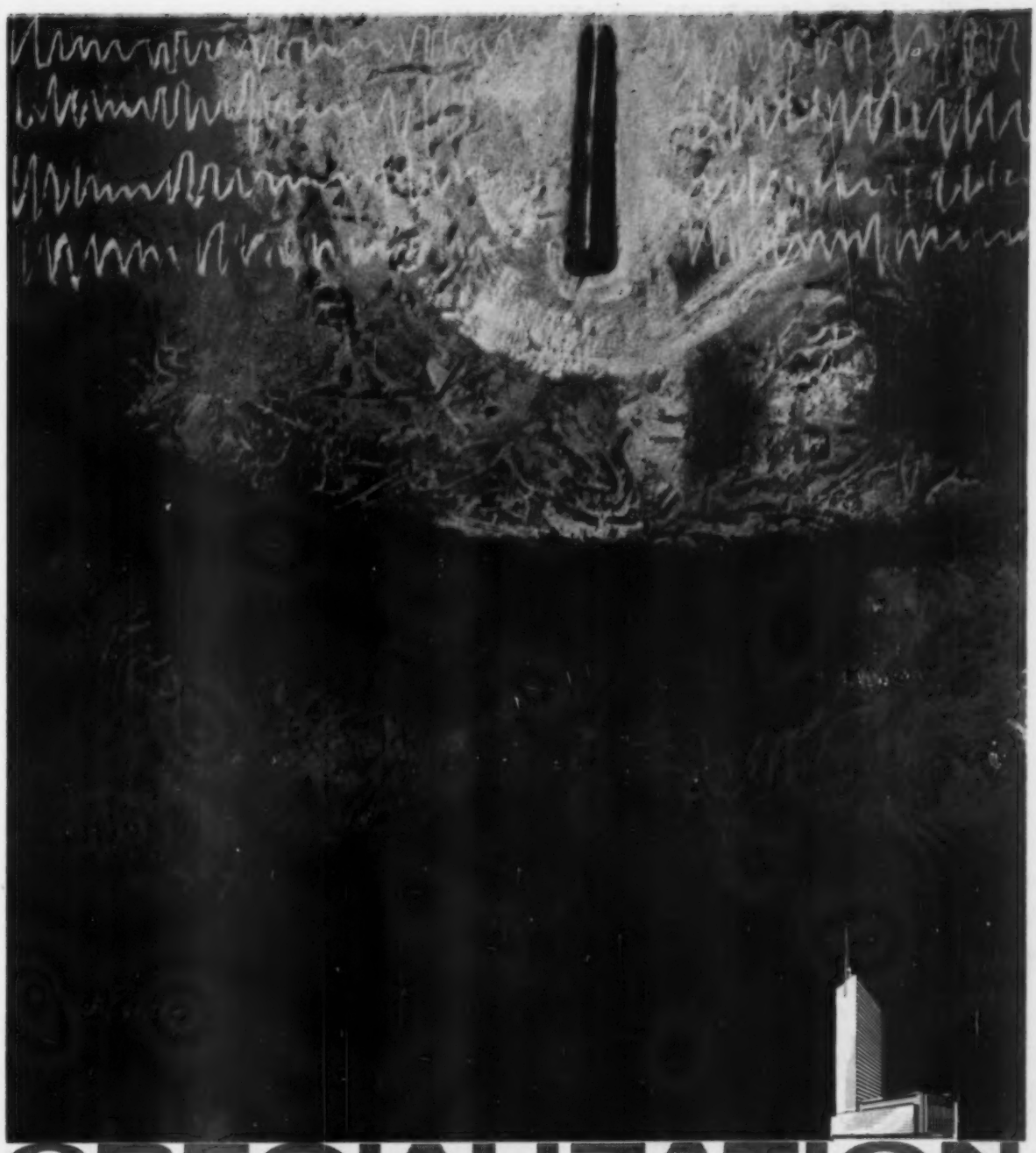

SPECIALIZATION

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course of oil

Is the Day of the Independent Waning?

THERE WAS ONE QUESTION asked and discussed more seriously at the TIPRO (Texas independent producers) annual meeting than imports and natural gas price controls. Members ask each other, "Is the independent oil man on his way out?" These Texas oil men knew producers who had already departed the scene and others who were facing bankruptcy.

Will the small operator in oil go the way of the small farmer, who apparently exists on subsidies if he exists at all? We are in changing times and an easy, sophisticated answer could be yes. We have big government, big business, big unions. The day of the small business man, the independent who is his own manager, might be moving into the last decline.

SOME MANAGERS in major companies can give you a good argument that the big companies are in greater danger than the independents. Persistent and unfounded Department of Justice indictments have drained capital and effort. Divorcement of pipelines and service outlets is a constant threat.

There is only one thing that would bring irreparable damage to the industry — and that would be loss of the independent or loss of the other half — the integrated company. If we lose either we're lost all the way.

If you saw the analysis of 75 oil companies in the May issue, you can see that independents (both producers and refiners) and integrated companies fared about the same in 1959. We've always included small companies in this survey because we don't believe you can understand the industry without them. Every year the results are the same — they fare well or badly together.

Large and small concerns in the petroleum industry are tied together tighter than a family and each has a vital place. New reserves in the U. S. have come principally from venturesome individuals. Processing and marketing have come largely from the major companies although some independent refiners and marketers have done exceptionally well. Research, the industry's progress-maker, is chiefly a big-company activity.

THE TROUBLE WITH the oil industry is that it is as international as mid-ocean and at the same time it is vital to national interests.

We have taxes in France, for instance, that smother the price of products. The U. S. is going in the same direction. We have nations like Ecuador and Indonesia that stifle operations by government pricing of products so low that it doesn't pay to distribute them.

Our problem is that of national interests imposed on natural demand. If the petroleum industry could have just one year of reasonable taxation (say only 10 percent on products) and no price controls in this price-control-conditioned world, economic progress everywhere would jump like a salmon going home. We would scale heights never seen before.

Our problem can only be faced together — both majors and minors looking outward to fight corrosion of markets everywhere.

INDEPENDENTS ARE NOT on the way out. They are vital to a free industry. They contribute even more than they realize to the spark of invention, the fire of initiative, the brake of balance.

Both economically and politically the thousands of small companies and individuals support and preserve the industry. Without their dynamic energy the petroleum business would settle into more rigid lines, susceptible to authoritative control.

What we say here, we've heard management of major companies say before. The independent is as necessary to the industry as oil and gas.

Ernestine Adams

Congrats and $25 for this quip to FABIO SORIA GALVARRO, Compañia de Perforaciones, S. A., Casilla 1215 — La Paz, Bolivia.

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petroleum profile

"PICK A COMPANY in which you have confidence, do the job assigned to you the best you know how; and your progress will keep step with your abilities." That's the advice given to scientifically inclined young people by the scientist of longest service at Gulf Research & Development Company. It has worked out pretty well for the advisor, Dr. Blaine B. Wescott, who is GR&DC's executive vice president as well as vice president-research of Gulf Oil Corporation. As such he directs one of the nation's top teams of industrial scientists including 1450 employees at the 53-acre research center at Harmarville, Pennsylvania, near Pittsburgh, and 400 more at Gulf's Technical Service Laboratory near Philadelphia.

DR. BLAINE B. WESCOTT

Vice President — Research, Gulf Oil Corporation

He traveled no easy road to this post.

About the time 15-year-old Blaine Wescott's eyes were being opened to the wonders of chemistry in Central High School, Syracuse, his father died. To gain entry to the scientific career that had become his goal, he earned his way to a BS degree at Syracuse University by playing the piano in a band and working on other nights and through the summers at the Crucible Steel Company laboratory. Casting about for a way to finance graduate studies, he tried several short-term jobs, the last bringing him to Pittsburgh as a junior physical chemist at the U. S. Bureau of Mines. There opportunity knocked when the University of Pittsburgh offered him a chemistry instructorship with the privilege of taking a full graduate course of study. Young Wescott cheerfully shouldered this double work schedule; and in 1920 won his MA in organic chemistry and in 1923 his PhD in physical chemistry.

The move to Pittsburgh proved equally decisive for his domestic and professional careers. Instructor Wescott married a Pittsburgher, Anna R. Kelly. Before completing his courses, he joined Mellon Institute there to engage over the next several years in research on wrought iron and cast iron. Gulf Oil had been sponsoring Institute fellowships on petroleum refining since 1911 and in 1924 established a second one to study oilfield corrosion. Dr. Wescott joined the staff in 1927 when Dr. Paul D. Foote, brilliant scientist and administrator, was brought from the U. S. Bureau of Standards as senior fellow. Dr. Foote became his younger colleague's inspiration, guide and close associate.

The research program grew rapidly and much of the staff was transferred to a separate building as Gulf's research department.

Dr. Wescott had already determined that here lay his life's work. "When I went with the Gulf fellowship," he recalls, "I soon made up my mind that I would cast my lot with the oil business. One of the first things I did was take a trip down to the oil fields. I liked the aggressiveness and friendliness of the people, the romance and the opportunity to be with a growing industry. Research was a comparatively new endeavor in oil, and a virgin field full of challenge was opening for research people."

In return Dr. Wescott contributed, as he puts it "something" to a better understanding of corrosion in oilfield equipment and of the methods of combatting it. He did some of the earliest work on acid-testing of wells to get rid of deposits and increase their production. He further engaged in a variety of metallurgical work of a developmental nature. These activities were formalized in GR&DC's materials and production chemistry division of which he became chief.

"I did not set my sights on any particular post," Dr. Wescott says. "My main concern was doing a good day-to-day job." Those jobs were done well enough to lead to his appointment in 1946 as assistant to the executive vice president, Dr. Foote. From that time on his responsibilities became those of research management. In 1951 he was advanced to associate director of research, in 1954 to his present position at GR&DC, and the following year to vice president-research of Gulf. He is a director of Dominion Gulf Company and of Callery Chemical Company.

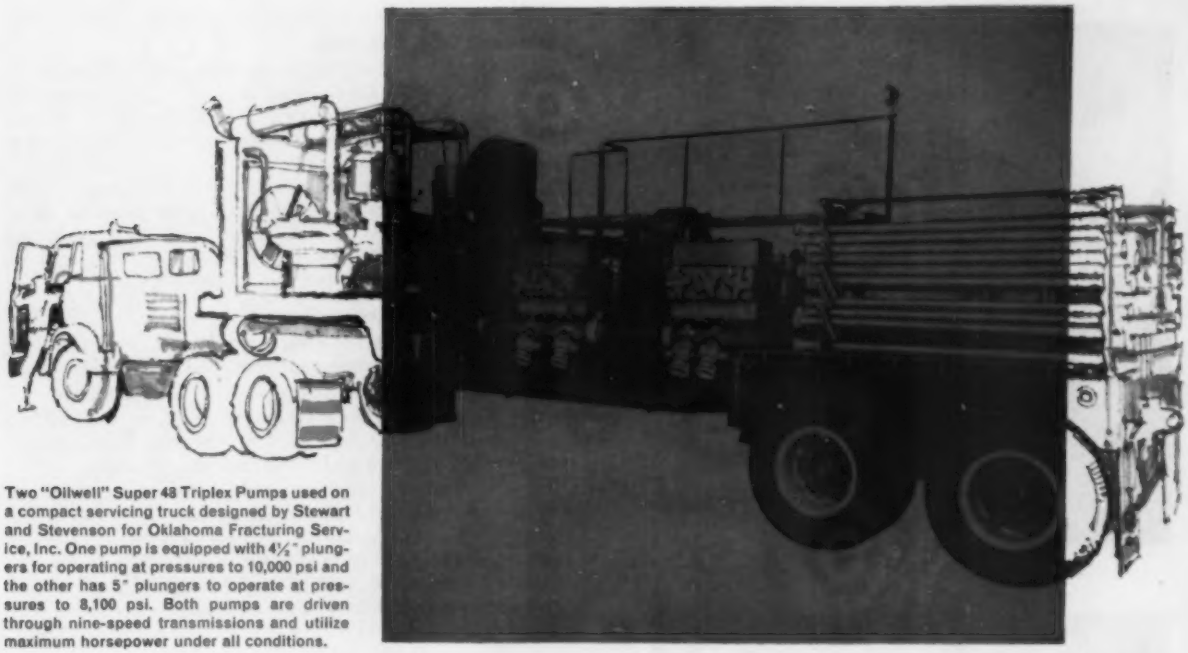
Certainly one of the most inherently modest executives to head such an extensive operation, Dr. Wescott concedes: "I prefer administration to my earlier research, probably because I never was a top-notch scientist myself." Whether or not this evaluation is accepted, none can doubt Dr. Wescott's concern with hiring "top-notchers" for GR&DC.

"There is plenty of room for genius in our research organization," he declares. "We recruit from the tops of the classes. We would welcome a Steinmetz or an Edison. In the realm of scientific thought and action we do our utmost to encourage the independent thinker. But we do require a certain degree of conformity to uniform working habits to preserve the morale of our large organization.

"A large part of my job" he elaborates, "is to act as middleman between the scientists and management. On the one hand, GR&DC seeks to provide the tools, the environment, and the rewards, both material and inspirational, that will stimulate scientists to productive research.

"About 10 percent of our total effort goes into fundamental research in scientific fields important to us. On the other hand, our primary responsibility is applied research which can be employed profitably by the company in its business. We try to keep familiar with operating problems and keep operating units familiar with what we can do.

"The people who work here deserve most of the credit for whatever success we have achieved," Dr. Wescott sums up. "We have an exceptionally able group of scientists, technicians and supporting personnel and our organization bears the stamp of their combined efforts. They make the job of 'selling' their accomplishments to management about as rewarding a task as I can imagine."



Two "Oilwell" Super 48 Triplex Pumps used on a compact servicing truck designed by Stewart and Stevenson for Oklahoma Fracturing Service, Inc. One pump is equipped with 4½" plungers for operating at pressures to 10,000 psi and the other has 5" plungers to operate at pressures to 8,100 psi. Both pumps are driven through nine-speed transmissions and utilize maximum horsepower under all conditions.

"Oilwell's" SUPER 48—

the No. 1 pump for tough fracturing service . . .

Plenty of horsepower in a small package—that's what you get with the Super 48 triplex pump, designed for fracturing and acidizing units.

The pump is light in weight and is well within road-width limits when mounted crosswise on the truck. Its modern welded alloy-steel frame provides plenty of strength for the maximum working pressure of 10,000 psi. The fluid end is a one-piece alloy-steel forging which includes the valve chambers and discharge connections.

High quality construction throughout assures low operating costs and minimum maintenance. For further information on the Super 48, contact your nearest "Oilwell" store or sales office.

USS and "Oilwell" are registered trademarks

Look at this data!

Type	triplex, single acting
Capacity	to 930 gpm
Pressure	to 10,000 psi
Input BHP	to 700 (intermittent)
Weight	8,240 lbs. (pump without skids)
Dimensions	7'6" x 4' x 3'6"
Power Frame	enclosed one-piece alloy-steel weldment
Fluid End	forged alloy-steel with quick-opening hammer-lug valve and cylinder-head caps
Plungers	CO-HARD, with pressure lubrication
Valves and Seats	carburized, alloy-steel, wing-guided insert type

USS **Oil Well Supply Division of United States Steel**

Executive Office—Dallas, Texas
Export Office—30 Rockefeller Plaza, New York 20, N.Y.

the conference table

How to Invade the "Common Market"

Many supply and service companies for the petroleum industry are moving into foreign operations along with oil companies. Recently when Rust-Oleum, a corrosion inhibitor manufacturer, opened a new plant in Haarlem, Netherlands, the company put out a complete review of how they had handled their plans for going into the Common Market in Europe.

President Fergusson explained "We've learned that you've got to use your first team in overseas selling. The markets are big, the need is there, and Europe is growth-minded." Rust-Oleum sent 16 of their top marketing men into the area. Planning began two years before the plant was completed. As Fergusson said "The day of viewing foreign selling efforts as an incidental or poor cousin operation is over."

First, a study was made of marketing methods, policies,

Old accountants never die —
they just lose their balance!

sales tools, and sales techniques to be employed through distributors in 16 or 18 countries. Initial planning indicated that Rust-Oleum should establish a basic foundation of sales potential and sales control system similar to the U. S. system.

Each of these 16 top men, who was assigned to work with so many distributors in a given country, and had to study the language, customs, and industrial atmosphere of the country in which he was to work. The 16-man task force was ready to leave June 9 to try their new selling techniques on expanding Europe.

They will spread over some 13 countries working with distributor management and salesmen and will help make sales calls. They will have charts and samples, mailing pieces, catalogs and brochures — all in six languages.

Aim of Rust-Oleum is to bring foreign sales up to approximately 25% of domestic volume.

Louisiana Goes Electronic

Oil and gas revenues bring the State of Louisiana nearly a quarter-billion dollars a year. In April a new system was introduced to keep better records with the aid of an electronic computer. More effective accounting is expected from the new control technique.

An IBM 650 tape computing system in the state's new Data Processing Center will monitor every barrel of oil — from the ground to the refinery — for 12,000 producing leases in 56 parishes. This will assure that the state receives proper severance taxes and mineral royalties.

How to Handle Public Affairs

Here's a short ABC of company public affairs. If you want to try it before the coming election, you'd better start soon.

1. Put someone in charge of local public affairs.
2. Make up a first-aid kit on public affairs. It should be pertinent material — for instance, directory of the legislature and information on how to register and when.
3. Place this material in a rack where it is accessible to all and keep the racks supplied at all times.
4. Take a poll and initiate a course of better information among employees — not only say whether you are for or against a proposition, but tell why. Monitor the newspapers and commend or criticize what they have to say about your industry.
5. Have a D-Day plan for letters to your legislators, to newspapers, to the governor, congressmen, etc.
6. Management should have a policy on most questions and it should be available to every employee. It must be set out simply and, in instances, should be specific. Management should be able to say why it is against added tax on gasoline, for instance, and why it is for a percentage depletion. It should be able to tell why it is for or against any economic problem that is being solved politically.

What Price Red Tape?

This kind of investigation by Congress we'd follow line for line — *an investigation into red tape*. The most prodigious effort was made by the Hoover Commission and most of the reforms are still gasping on the ropes. If all the cost of government red tape were totaled, we'd have enough savings to emaciate the national debt. We've seen stacks of copies for FPC records from natural gas producers that cost more to make than the profit from the gas they sold.

At a recent national meeting of petroleum company librarians, a Columbia University professor told about being awarded a government grant for geology research. The government snowed him with so much paper work that he had to lay off an assistant and hire a secretary to handle government mail.

We have to have records. A whole civilization can vanish without records of their history; a business can fail if there are no records to guide it; a government must probe its nation's progress to know its strengths and its weaknesses. But we don't need nine duplicates of a letter (which we once received) each a different color.

Is there any way to cut this burden of paper-work that looks like flimsy tissue and grows into an iron old-man-of-the-sea, sitting weightily on our shoulders?

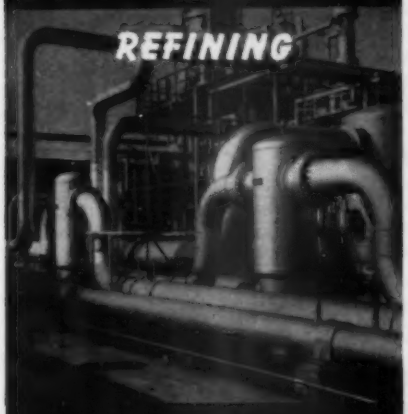
We carried an article, "Weigh Your Paperwork," (The Petroleum Engineer, September, 1959) by two Sinclair Pipe Line men on what their company has done to eliminate non-essential paper work. They go about the job carefully and scientifically. They save money and effort and as a result do their routine records much more efficiently. One difficulty is in translating the results into economic gains. This is a little out of the sphere of regular accountants but it would be helpful if some economist would create a formula evaluating the worth of recording that could be fitted to specific cases.

Much of our effort in *The Petroleum Engineer* magazines

PRODUCTION

Pictured above is a Peerless Line Separator removing moisture from fuel to drilling rig.

REFINING



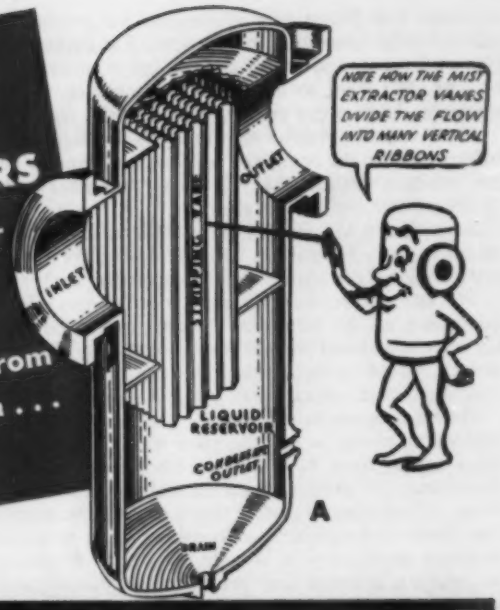
These two Peerless Line Separators are doing an efficient job of mist extraction in the Petrochemical plant in Kentucky.

PIPELINE

FIVE Peerless Line Separators are shown above as they handle carry over from large scrubbers.

PEERLESS LINE SEPARATORS

Outstanding for the efficient extraction of liquid mist from gas or steam . . .



HIGH EFFICIENCY—HIGH CAPACITY LOW PRESSURE DROP

Thousands of installations throughout the oil industry . . . production, pipeline, refining and petrochemical . . . prove the Peerless Line Separator principle to be one of the most outstanding methods available for the extraction of liquid gas, steam or air.

Drawing A above shows the arrangement of the vanes in the Separator. Drawing B is an illustration of the Peerless Principle.

The mist extractor combines the forces of impingement, centrifugal motion and surface tension to obtain its high efficiency. The path of the gas, etc., through the unit is constantly bending causing semi-violent turbulence and rolling of the gas against the walls of the vane. Impingement and centrifugal force combine to contact the droplets with the vanes, where they coalesce, and surface tension then causes them to cling to the vane's surfaces. Gravity and the impact of the gas steam then drive the droplets into the pockets where they roll down the vanes and out of the gas stream.

Through the Peerless method of mist extraction, the gas is stripped dry long before reaching the end of the vanes.

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For any capacity
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For corrosive conditions
With removable vane units
With extra body length
With connections for accessory equipment
For pressure drop requirements of less than 6" water
For any vapor-liquid ratio
For any piping requirement

SPECIAL DESIGN SEPARATORS FOR ANY REQUIREMENT

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REPRESENTATIVES IN ALL PRINCIPAL CITIES

to collect and disseminate information for practical use requires a large amount of paper work. For surveys we analyze and revise and try to capsule for minimum effort in reading. We want to avoid any resemblance to red tape methods. After every survey, we study the results to see:

First, was it worth all the travail? Can our readers and informants use the combined opinions and data we have (in our position outside any petroleum company) been able to collect and evaluate for them?

Second, can we simplify the work and reduce questionnaires to more basic items and leave out parts that may be interesting but are too intangible for specific use?

We and our readers agree on most of the information collections we do. Otherwise the companies who aid in the survey method and we who do the combing and make the curves, would — but quick — give up the project. In this straining world, effort is too precious to lose.

On occasion we have decided — unilaterally as they say in diplomatic circles — that the game wasn't worth the candle (this saying must have come from pre-petroleum days). Sometimes the project dies a natural death and the whole thing is forgotten. At other times we've been surprised at the letters and telephone calls asking when such-and-such statistics are going to be brought up-to-date. We always bow to reader's interests and get back to questionnaires and calculators.

We are avidly red-tape conscious. We try not to ask one question of a company or an individual that doesn't bring back bread with butter on it for the person, the company and the industry. Statistics are the directing finger for modern business. As in most things, however, it's quality — not volume — that counts.

We must — in government and in industry — discriminate between quantities of statistics that simply create red tape and data with a purpose. Red tape must be reduced and meaningful data must be preserved. We have the demanding task of marking the line between.

Lists Gas Price Factors

In his speech before the Texas Independent Producers & Royalty Owners Association at Tyler May 2, Frederick Stueck, a member of the Federal Power Commission, named 20 factors which influence the price of gas. The list will show why FPC has considerable difficulty in the task of setting a fair price on various gas produced for interstate market. In case you do not know them, here they are:

1. **Depth of wells.** The deeper the wells, the more expensive the gas. Depth is recognized in the case of oil where oil produced from deeper wells is given greater allowables.

2. **Is the gas produced on dry land, or marsh land, or offshore?** For the same depth of wells and the same volume of gas, the wetter the surface, apparently the more expensive the operation (although this is disputed). As in the case of depth of wells, this factor is also recognized when setting up allowables for oil.

3. **Distance of the wells (field or production) from (1) pipeline, and (2) the ultimate market.** If the wells are at great distance from the pipeline, the gas apparently is not worth as much as that adjacent to the pipeline. Likewise, the farther away the well is from the ultimate market, the less valuable.

4. **Producing costs have risen sharply in recent years.** This would be reflected in a "cost" determination, but the facts seem to be that most gas is not purchased on the basis of cost determination alone, although the buyer has to recognize these factors when comparing past prices with prices being offered:

(a) *Cost of exploration* is increasing, especially in face of poor structure prospects. The more expensive methods of exploring for gas are increasingly used.

(b) *Costs of obtaining leases* are going up as a matter of fact. Even though the increased value isn't there, the sellers of leases are considerably influenced by rising prices and their asking prices are continually increasing. I am informed that in many cases royalties are requested on the basis of ⅙, as distinguished from the old standard ⅛ or smaller fractions which used to control.

(c) *Drilling costs* have risen sharply. The cost of materials as well as labor is up.

(d) *Operating costs* are rising in many cases because of poor wells and fewer wells per field.

5. **Competition.** The price offered for gas is influenced considerably by the number of sellers in the field and the number of buyers. This is a matter of supply and demand.

6. **Historical considerations.** In many cases, for no logical reason, it is a fact that prices are sometimes governed by historical price levels. These historical price levels are usually connected with a region and/or a district, such as the railroad districts in Texas. The wider regional areas such as West Texas, South Louisiana, etc. are examples of regions where historical prices have an influence.

7. **Term of agreement.** The longer the contract term, the more valuable it appears to be to the buyer.

8. **Ratio of daily contract quantity (DCQ) to reserves.** From the standpoint of the seller, there appears to be a desire for a faster payout. From the standpoint of the buyer, this tendency gives a lower life index.

9. **Quality.** Obviously, a higher Btu gas or a gas with less carbon dioxide, sulphur, etc. is more valuable to the buyer. Likewise, the presence or absence of hydrocarbons has a great bearing on price.

10. **Price terms.** The buyer also seeks contracts which do not include favored nations clauses or price redetermination clauses. The firmest price for the longest period is most desirable to the buyer.

11. **Take-or-pay-for provisions.** A lower take-or-pay-for clause is worth much to the buyer.

12. **Operating swings.** It seems to be a fact that gas is more valuable to a buyer where the contract permits larger permissible operating swings.

13. **Taxes.** Provisions with respect to reimbursement for taxes or the inclusion of taxes within the price is important.

14. **Delivery pressure.** The provisions for delivery pressure in the contract and the way it will probably work out in the particular field is of significance in fixing the price for the gas.

15. **Spot or short-term purchases.** Unless such purchases are adequately backed up with dedicated reserves, this type of contract is certainly of much less value to the buyer than the long-term contract.

16. **Proved reserves.** If the gas reserves dedicated under the contract are production proved reserves, they are considerably more valuable than those reserves determined by such methods as core evaluations, etc.

17. **Delivery in field.** Delivery at a central point in a field is an advantage to the buyer over deliveries at the individual well heads.

18. **Recycled gas.** Such gas reserves are more valuable because of the assurance of the reserves and known availability.

19. **Competitive fuels.** Unquestionably, the price of competitive fuels in the area of ultimate delivery must have a bearing upon the price offered for gas.

20. **Total quantity of reserves available.** Contrary to most purchases (where the greater the quantity, the lower the cost per unit), with natural gas, the greater the quantity, the higher the price.

Good Wells Make Good News

June, 1960

Dowell engineers are reporting an unusually high ratio of successful fracturing treatments. Here are four recent examples:

- **Mobile County, Alabama** (Old Oil Well) This well was producing from both the upper Donovan from 10,829 to 10,945 feet and the lower Donovan from 11,382 to 11,394 feet. Each zone was fractured separately with Waterfrac using a total of 23,000 gallons gelled water and 80,000 pounds 20/40 sand. This was the first use of water as a frac fluid in this field. Injection was approximately 18 bpm at 4500 psi down 2⅛-inch tubing. Before treatment well made 19 bopd from upper zone; lower zone had been temporarily abandoned as non-productive. Two weeks after treatment, upper zone was making 120 bopd. Pump was moved to lower zone which produced 113 bopd after five-day test.

- **San Juan County, New Mexico** (New Gas Well) This well was completed into three sections of the Dakota. Each section was fractured separately. To keep costs as low as possible, Dowell used a new perforating and stage-fracturing technique: Abrasijet* was used to perforate and a retrievable bridge plug assembly was run below the tool. The frac fluid was fresh water with two pounds of sand per gallon. Slick Water additive was used to reduce friction. Injection for all stages was over 40 bpm at 2300 psi. First, the lower section was perforated and fractured with 50,000 pounds sand. Second, bridge plug was set above the lower section and the main bench was perforated and fractured with 100,000 pounds sand. Third, the bridge plug was released and reset above these perforations. Then the upper section was perforated and fractured with 100,000 pounds sand. All work was done without removing tubing from hole, saving over $4000. On test, well potentialled 13,000 mcfd and produced 5640 mcfd into the gathering line. This is at least 30 per cent better than any other well this company has in the field.

- **Ector County, West Texas** (New Oil Well) This well was completed through perforations into the San Andres at about 4390 feet. It made only a show of oil. Operator wanted an economical stimulation job. Using the Frac Guide* Dowell engineers designed this treatment: First, 1000 gallons BDA* (Breakdown Acid) were jetted against perforations. Then Sandfrac* was used. 10,000 gallons lease crude with F.L.A.* (Fluid Loss Additive) carried 20,000 pounds sand into formation. Injection was down annulus at 10 bpm. After treatment, well's rated potential was 700 bopd.

- **Grant County, Kansas** (Old Gas Well) Production from this well — completed in 1949 — had declined to 403 mcfd. The operator decided to fracture the upper part of the Hugoton since he believed most previous production had been from lower zones. A 6000-pound sand plug was used to fill up 165 feet. Then Riverfrac* was used. 94,000 gallons fresh water and 80,000 pounds sand were injected down casing at 66 bpm and 800 psi. Six months after treatment, deliverability had increased to 2253 mcfd.

For detailed information — or for prompt service — dial Dowell. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela and Argentina. Dowell, Tulsa 1, Oklahoma.

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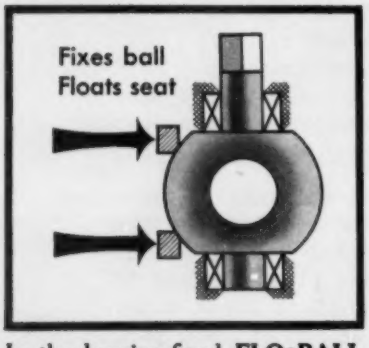
Can A Ball Valve Operate, Cycle After Cycle, With No Maintenance At All?

Read this remarkable answer, and discover an amazing engineering feat.

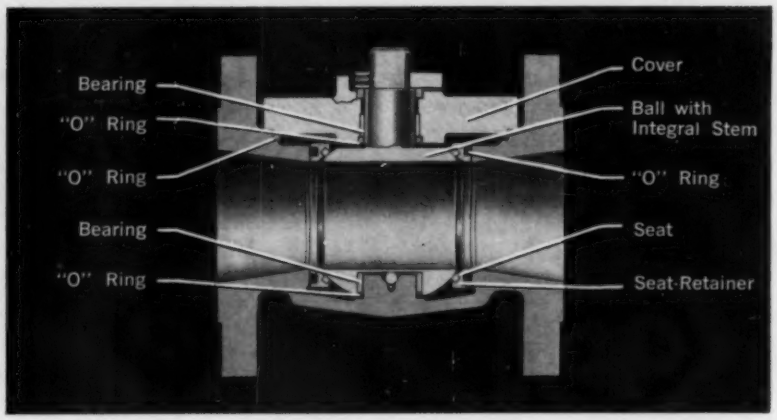
As most engineers know, ball valves offer a number of distinct advantages over all other types of valves . . . 90° on-off, minimum pressure drop, positive on-off indication, no lubrication, and compactness. In common with other valves, however, the design was insufficient to overcome the problem of continual maintenance.

Four years ago, this problem was faced by Hydromatics, Inc. in the valves that they produced for use in missiles, aircraft and ground support systems. Then, as today, all other ball valves were built with a ball that floated in its socket, and sealed by being forced against its seat by the pressure in the line. This caused seat distortion which made early replacement necessary.

Hydromatics tried a different approach. Rather than use the traditional floating ball, their engineers fixed the ball in bearings.



In the bearing-fixed **FLO•BALL** valve all pressure forces exerted on the ball are transmitted to low-friction bearings, thus eliminating down-stream seat distortion due to ball load. The pressure balanced seat, with its teflon sealing surface, is continually self-adjusted by the O-ring in the seat retainer.

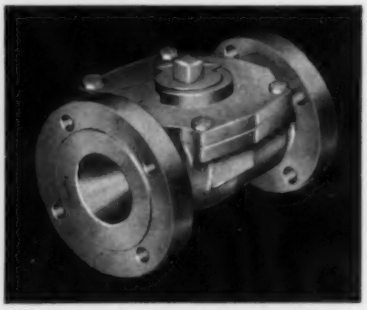


This O-ring acts as a self-energizing force that keeps the teflon seat always in contact with the ball. This insures positive sealing without seat distortion, and minimizes seat-resisting frictional forces. The combination of these low frictional forces results in low operating torque and extremely long seat life.

The bearing-fixed **FLO•BALL** valve proved itself immediately. Hundreds of missile and spacecraft systems, previously impossible, were made possible with these valves. The X-15, America's first manned space vehicle, for instance, has a Hydromatics **FLO•BALL** valve at its heart. Since its inception, the **FLO•BALL** has been used in more varied applications than all other ball valves combined.

Now, after the toughest application testing in history, bearing-fixed **FLO•BALL** valves are being mass produced for industry. They are available for off-the-shelf delivery to standard ASA dimensions in semi-steel, carbon steel, stainless steel, and aluminum. They operate at pressures to 600 psi, temperatures to 400°F and hold vacuum to 10^{-6} mm. of Hg!

The bearing-fixed **FLO•BALL** offers extra ball valve advantages. Top loading for easy access without removing the valve from the line, plus three features that are absolutely unique! Self-adjusting seats which automatically compensate for wear, proportional sealing force which automatically increases with line pressure, and the lowest torque, by far, of any valve. These combine to make the **FLO•BALL** valve virtually maintenance-free!



How long does it last without maintenance? Frankly, we don't know, since the first valves we ever built are still going strong and outlasting other valve types by more than 10-to-1. But don't take our word for it. See for yourself. Call, write or TWX for further information.

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Since oil and gas are produced, transported and processed throughout most of the world, Dresser's operations are conducted on an international basis. Wherever you are, Dresser is represented nearby with products and technical services which are standards of comparison the world over.

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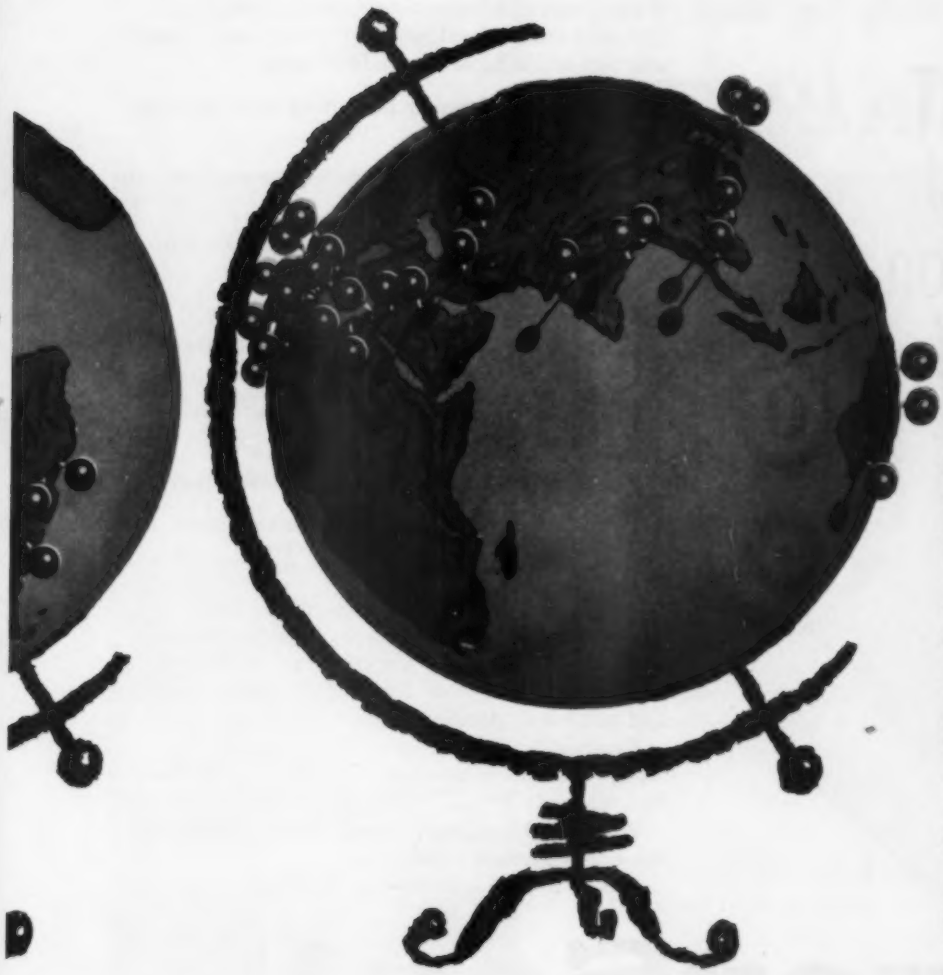

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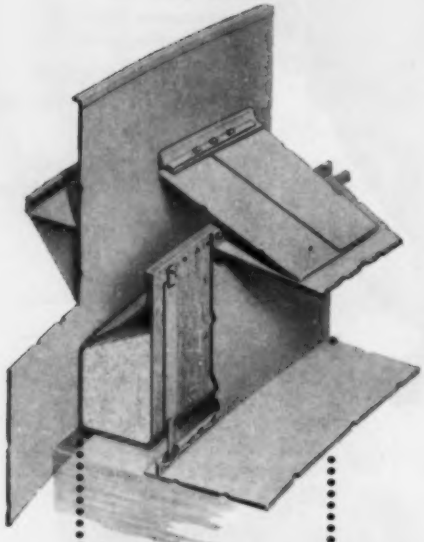

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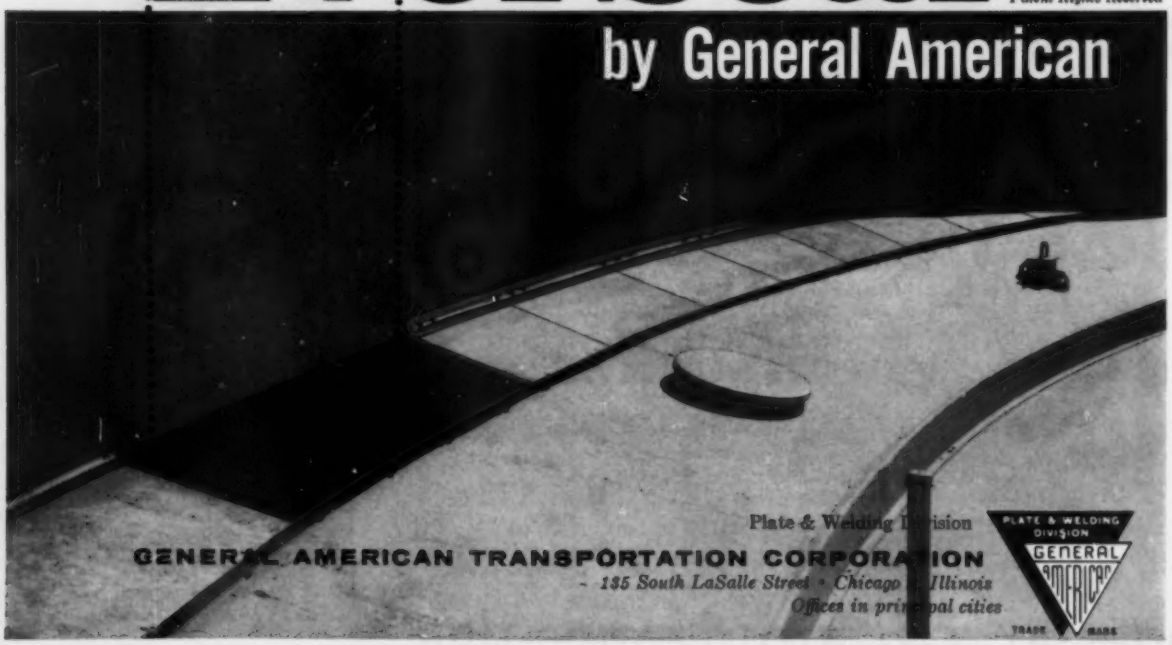

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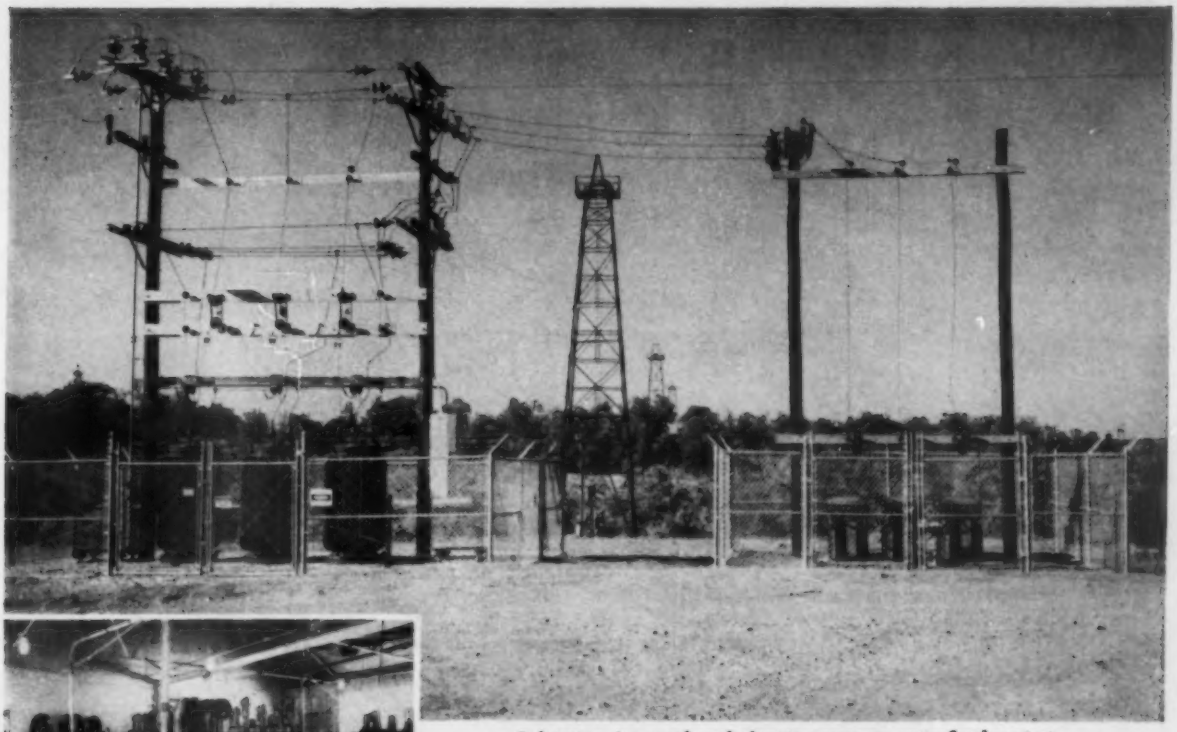

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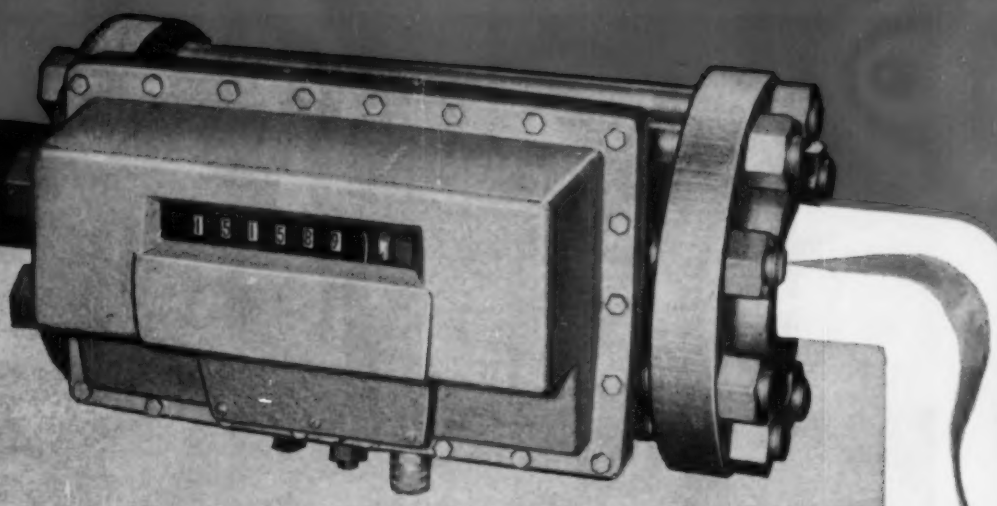

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The lonely camp of an Aramco seismograph party is in the center of this scene from Rub' al-Khali, which means "Empty Quarter." The industry in 1959 pushed into many empty quarters searching for oil. (Photo Arabian-American.)

World-Wide Competition Sharpens Oil Paradox

ERNESTINE ADAMS

Petroleum activities in 125 countries and areas are reviewed in this 13th annual survey

All over the world, in dangerous inaccessible corners, the international petroleum industry digs for oil as if it were precious as gold.

Then the same industry walks into the market and sells oil as if it were water.

Costly to find, cheap to buy — that is the paradox of petroleum. That is the factor that puzzles our friends and is used as a weapon by our enemies.

This annual review of world-wide operations spotlights a search for oil as intense and as widespread as it has ever

been. At the same time the oversupply resulting from earlier successful searches depresses crude oil prices. Nor is overcapacity limited to production—it follows right through processing and transportation.

This odd situation comes about principally because of competition on several levels.

First, there's competition between companies in the industry. No oil company—or individual, for that matter—can afford to run out of oil and stay in business. Nor can a concern wait until its stocks are low to start exploring for more.

The time lapse between discovery and marketing can be deadly. President Nickerson of Socony Mobil reminded listeners in a speech once that even the Middle East bonanza did not come easy. He recalled: "In 1922, the Secretary of State asked for volunteers among American companies to join European interests in an enterprise in what had been the Turkish Empire in the Middle East. Fourteen American firms originally indicated a willingness to invest in the enterprise, now known as the Iraq Petroleum Company.

"However, over the next few years, the prospects for oil in the Middle East looked so gloomy and the prospects in this country looked so good, that only 5 of the 14 actually entered the venture when the terms of American participation were finally agreed on in 1928. Three of these dropped out inside six years. Only two, Socony and Standard of New Jersey, remained as the American participants.

"For years we kept sinking more money and more money into our Middle East investment. The pay-out—which ignores interest on the capital invested—stretched out to 1955, more than 25 years after the first dollar was invested. The Iraq Petroleum Company is now a profitable enterprise, but I hardly think any of us would volunteer to invest heavily today in a venture half-way around the world which we knew would not pay out for over a quarter of a century."

Second, there's competition between nations. Every country is trying to become as self-sufficient in oil supplies as possible. If no potential oil deposits are evident, then refining and marketing facilities are sought for the national economy.

Finally, there's the political competition between the Communist Group and the Free World. This struggle between the two became evident in 1957* and has grown in area and intensity ever since.

Today's critical political empasse between the East and the West emphasizes again the stellar role of oil supplies in all temperatures of war — cold, warm, or hot. Ample and accessible supplies of oil products are as necessary as soldiers.

Soviet competition is many sided. It pushes domestic development intensely, provides technical and financial aid to countries on its perimeter, and trades oil at cut-rate prices throughout the world.†

This looks like a pretty dismal picture of the international oil situation. Are there any bright spots?

Of course. One thing to remember is that world demand for oil and gas has a steady expansion that crosses every boundary. This spells economic progress as precisely as the letters do. Increased use comes in spite of taxes on oil and its products that in most nations are more than the cost of the product to the consumer. Plentiful supply helps keep distribution active and improves living standards everywhere.

Another benefit of world competition is leveling agreements between governments and companies. H. W. McCobb, vice president of Standard-Vacuum, pointed this out in a February 1960 release. He said, "The very fact that overcapacity exists has brought about a better understanding between producing nations and the international oil companies. Relationships, for the most part, are amicable, and there are determined efforts on both sides to solve the problem so that all may exist profitably. An example of these efforts is the modified attitude toward changing the 50-50 profit formula.

"The Sudan rescinded a provision which called for upping the government's share to 70% after 10 years of development and a straight 50-50 was passed. Spain enacted a 50-50 law during the summer covering the Spanish mainland and its African possessions.

"A new oil law also was passed in Greece which further solidified the time-tested formula. Meanwhile, the Arab League dropped its efforts to modify existing contracts. The League also did not press for a greater share in new contracts."

Heavy supply and light profits have had one other important effect upon the industry. They have improved operations as nothing else could. Every branch of the industry has felt the pressure. In the last two to three years we've easily doubled our rate of technical advance. We've improved our organizations. We've found cooperative enterprises good vehicles for sharing the risk. We've learned refineries need constant change to keep efficient, that an early petrochemical plant in a foreign country can pay out fairly quickly.

Oversupply is not an unmitigated plague.

Most of the optimism found in the industry comes from those who point to the almost frightening demand foreseen in the future. Chase Manhattan in late 1958 released a forecast that estimated a 29,500,000 b/d demand in 1967. This is approximately a 50% increase over present consumption and will require huge reserves.

M. J. Rathbone, president of Jersey Standard, told an API meeting last month that expanding demand for oil products is a field with great "potential payoff."

In 1959 demand rose 5½% in the Free World and 14% in the Communist block. Natural gas consumption is more difficult to study but percentage increase was obviously higher. Russia consumed 25% more.

Refining capacity expanded by only 2% but more important was the increase in petrochemicals. OEEC reported that production of petrochemicals went up 50% in 1959 over 1958. In 1958 petrochemical output was 813,000 tons compared to 1,225,000 tons in 1959 in the principal Western European nations.

Pipelines are being strung over England, Europe, North Africa, Russia, Japan—many parts of the world. Quick evaluation of new reserves, and efficient pipelaying hastened new supplies to market.

U. S. companies are flocking abroad as never before. Those of other countries are stepping up activities. German, British and French oil equipment industries are expanding. U. S. supply and service companies show increased sales abroad. Dresser Industries reported its foreign sales were only 10% of total volume in 1950 and now are more than 30%. In its first quarter report for 1960, Halliburton said foreign operations reflected increases in both revenue and net profits at a time when domestic earnings were down.

To read the happenings of 1959 in this review gives you a thrilled glimpse of a dynamic industry that pushes eagerly into unknown areas, handles its affairs diplomatically, and brings a better life to all men.

*"Oil Companies Face USSR Competition", *The Petroleum Engineer* July 1958, Page A-17.

†J. A. Cogan, vice president of Imperial Oil, said last year, "Current shipments are about 250,000 daily, which is well below 2% of the Free World's demand. Most of the shipments are to Europe, with only about 25,000 bbl daily reaching the Western Hemisphere, principally Argentina."

EDITOR'S NOTE:
Figures are average for 1959 unless otherwise stated.
(1) R.C. — Figure indicates number of refineries; R.C.—Total refining crude capacity. Runs — Crude runs to stills.
(?) — Information slight.

ADEN

(1) R. C. 120,000 b/d
Runs 91,000 b/d

Only exploration permit is owned by Petroleum Concessions. Ltd. (Iraq Petroleum Company). This includes Hadhramaut and island of Socotra.

One survey party, the first to be equipped for seismic operations, had started work in the northern Hadhramaut in the autumn of 1959. For the past three years geophysical survey parties have been at work in the Hadhramaut after geological surveys had been carried out.

AFGHANISTAN

Soviet geologists have been doing geological prospecting and survey work for oil in north Afghanistan for about two years now under the Soviet-Afghan economic agreement of July 30, 1957. V. A. Frolov, chief geologist of the Foreign Relations Administration of the USSR Ministry of Geological Survey and Conservation of Mineral Resources, reported to Moscow News after returning from Afghanistan in March 1960.

He said that the work "we have done has established that the geological structure of northern Afghanistan has many features in common with adjacent oil and gas-bearing areas of Soviet Central Asia. It should be added that the area of potential oil and gas deposits stretches over the entire territory of northern Afghanistan.

"This is borne out by the results of drilling work: The first trial bore hole, sunk at an early stage of geological survey in the vicinity of Sar-i-Pul, helped establish the presence of good oil reservoirs and yielded small flows of high grade oil, while the second well showed good signs of oil and gas. In addition to these two wells, preparations were started for drilling in two more promising areas. The drilling is being carried out in close cooperation with Rumanian and Afghan specialists. The drilling rigs supplied by the USSR have worked well."

Great attention is being given to training. Last year and this we shall have trained about 450 Afghan citizens in various (oil industry) trades and professions. Over 200 of them completed their training before the end of last year.

Many Afghan citizens are already working independently as shift foremen, diesel operators and deep well drillers, electric welders, crane and tractor operators, employed on assembling of oil rigs, in blasting operations, in seismic operations and as assistant geologists in field and laboratory work.

Apart from undergoing training on the spot, some Afghan specialists also come to the Soviet Union to make a deeper study of oil prospecting and extraction. At present there are 10 Afghan specialists training at oil enterprises in Baku.

ALASKA

Prod. 650 b/d

The 49th state's Department of Natural Resources has reported oil production of 107,000 bbl from mid-1957 to September 1959. During the same period Alaska netted more than $10 million on oil and gas leases.

Prospects for production in Alaska were strengthened with discovery of new field on Kenai early this year by Standard of California and Richfield. This combine made this first commercial oil discovery in 1957.

Plans are made for a 20-mile, 8-in. $4 million crude oil pipeline from the Socal and Richfield oil wells to Cook inlet. The companies had previously announced the pipeline would be built when 3000 b/d output was assured.

Substantial gas reserves were discovered by Ohio Oil and Union of California, also on Kenai Peninsula. The first well tested 31 million cf/d. A 65-mile pipeline to Anchorage is planned to supply that city.

There are 12 geological crews and 12 geophysical crews operating. The 8 drilling rigs in the area drilled 7 wells in 1959, resulting in 2 producers and 5 dry holes. Since the Richfield discovery on Kenai in 1957, there are now 4 oil-producing wells.

Exploration attracts more firms. A 5-year contract with Pan American Petroleum Corporation for exploration and development of 465,280 acres

Here near the shore of the Cook Inlet on the Kenai Peninsula are the first commercial gas deposits in Alaska. Ohio Oil Company and Union of California found the new gas field in 1959. A pipeline will connect it with Anchorage, which is 70 miles to the northwest. (Ohio Oil Photo)

in the Napatuk Creek area of Alaska was announced in September. Bristol Bay Oil Company, Sunray Mid-Continent and Empire State, holders of acreage within the area, are expected to join Pan American in an operating agreement for the work.

British Petroleum Exploration has been granted leases on about 50,000 acres in the Umiat region and has options on another 120,000 acres in the Umiat and Gubik areas. B-P has also taken an interest in a deep test well being drilled by Paul G. Benedum in the Nulato Basin, adjoining the Yukon River in Western Alaska.

A joint Japanese-American oil exploration program on the Kenai peninsula south of here was announced by George Grimes, president of Polaris Exploration Company. Grimes said his firm signed a $1,250,000 contract with Teikoku Oil Company, Tokyo, and drilling of the first well is expected to begin this year.

A 5-year contract for Shell on 450,000 acres southwest of Bethel was approved. Shell is required to drill at least three exploratory wells and spend a minimum of $950,000. The company will relinquish half the acreage before 1964.

This is the eighth development contract currently active in Alaska. It is part of about 4,600,000 acres within the six major areas being explored. A total of 13 companies will participate in development.

Reserves: Bureau of Mines estimates that 122 million bbl of oil can be extracted by primary-production methods from certain formations in the Umiat field, in Naval Petroleum Reserve No. 4, about 350 miles north of Fairbanks, Alaska. The Bureau estimates total oil deposits in this field at over 930 million bbl. An undetermined amount of petroleum, in excess of the 122-million bbl primary production estimate, may be produced by carefully engineered secondary recovery methods, the Bureau said.

Consumption: 16,000 b/d oil products.

ALBANIA

Prod. 9500 b/d **(2) R. C. 6000 b/d**
Runs 4800 b/d

Albania's 1959 crude output rose to 479,000 tons. In 1958,* according to the official Russian magazine *Voprosy Ekonomiki* (Economic Problems) it was 8060 b/d; gasoline production was 625 b/d and petroleum bitumen production was 3650 b/d.

Coinciding with its failure to meet production goals in 1958, Albania slashed its exports of crude to Russia from 4150 b/d in 1957 to 1500 b/d in 1958.

After increasing sharply in 1956 and 1957, Albanian crude production appears to have leveled off. Albania's Second Five-Year Plan goal of 18,000 b/d in 1960 now seems unattainable. The 1961-1965 Plan, however, sets a goal of 42,000 b/d crude oil output.

Consumption: 5300 b/d.

* Note: Russian figures on Albanian crude production in 1958 do not agree with API's Petroleum Facts and Figures data for that year. API shows Albanian crude output 2,690,000 bbl in 1958. The Russian figures cited above show Albanian production at about 2,930,000 bbl in 1958.

ALGERIA/SAHARA

Prod. 20,000 b/d

Pipelines are the key to production in this rich new oil and gas area. The first 24-in. crude oil line from Hassi Messaoud to Bougie (412 miles) was opened at the end of 1959. It will be expanded this year. A second 24-in. line from the Edjele area to the Tunisian Coast (491 miles) is under construction. Plans were made (construction began this year) on a 24-in. gas pipeline from Hassi R'Mel 327 miles to supply Algiers and other cities with natural gas.

The article on Algeria/Sahara by Dr. Alain Perrodon* gives a detailed account of operations to date. In March 1960 concessions covered 270,031 sq miles, most of them held by combines of French and foreign concerns.

Party months for seismic crews were 267, gravity 15 and air magnetometer, 5 in 1959. Exploration costs reached almost $90 million.

The 41 drilling rigs in the area completed 150 wells. Of 37 exploratory wells, 7 found oil and 4 gas production; of 113 development wells, only 5 were dry holes. Production shot up to 94,322 b/d at end of year when pipeline went into operation. The Hassi Messaoud-Bougie line is expected to transport 280,000 b/d in 1961.

Reserves: Oil, 4 billion bbl. Gas, 38 trillion cu ft.

Consumption: 30,000 b/d.

* Global Notebook on Algeria/Sahara, *The Petroleum Engineer*, March 1960.

ANGOLA

Prod. 1200 b/d **(1) R. C. 2700 b/d**
Runs 2200 b/d

Petrangol, a subsidiary of Petrofina and the Angolian Government, has the only production in this Portuguese possession on the West Coast of Africa. The company had an exploration permit in 1952, turned into a concession contract in 1953. Another test in Galinda found oil and one at Bom Jesus looked promising.

Cabinda Gulf Oil Company was granted a concession in 1957 and has a rig drilling in the enclave of Cabinda, which lies north of the estuary of the Congo and belongs to Angola.

In 1959, 15 wells were drilled in the area, 7 of which are producing. The latter brings producing wells to a total of 15. Two geophysical crews are operating and there are 5 drilling rigs in the territory.

There is a topping plant at Luanda, the capacity of which will soon be increased to 3600 b/d.

Consumption: An estimated 4000 b/d.

ARGENTINA

Prod. 122,418 b/d (14) R. C. 252,000 b/d
Gas 48,360 mcf/d **Runs 235,000 b/d**

President Arturo Frondizi, his minister of Economic Affairs, Alvaro C. Alsogaray and other dedicated administrators deserve a salute. Rapid development of a vital oil and gas industry is one indication of their success against great and numerous odds. The nation has advanced in many ways, none more spectacularly than in petroleum.

Dr. Horacio Aguirre Legarreta, president of Yacimientos Petroliferos Fiscales, government oil and gas entity, has proved his capability of handling operations in a rather tricky situation where public opinion had to be reoriented to accept the value of contracts with foreign operators.

Since last year production has risen 24% and since the new petroleum policy was set in 1958 output has increased almost 30%. This extra crude oil for its refineries has cut down Argentina's outlays for imports. These amounted to $206 million in 1956; $270 million in 1957; $226 million in 1958, when production started up, and $191 million in 1959. Plans look to self-sufficiency in petroleum by 1962.

In last year's Round-Up (June 1959) you'll find the big contracts listed that have hastened the nation's oil and gas development.

Six U. S. companies agreed to invest some $292 million in petroleum development in return for exclusive concessions.

They are to find and develop oil and gas reserves and sell to YPF at contracted rates. Of these Pan American International and Carl M. Loeb, Rhoads and Company have already found oil and are producing. There are around 100 rotary rigs working.

Late in 1959 Ohio Oil and Continental Oil each made bids to explore for and produce oil for sale to YPF, respectively from areas in the north and the south of the province of Santiago del Estero. In both cases an expenditure of $32 million would be undertaken during an exploratory period of 10 years. The production period would

Here is an Italian drilling crew working in South America. The company, SAIPEM, is a subsidiary of ENI. It has a contract with YPF to drill 300 wells. General Manager Jose Badolato is in black pullover with sun glasses and Assistant Manager Pittin is at right with hanging camera. SAIPEM has four drilling rigs and three work-over rigs in operation. In the camp are 120 Italians and 100 Argentinians. Kerr-McGee and Southeastern Drilling Company (both USA) are working in the area. Relations are friendly among the men of all nationalities.

be 30 years and the oil would be delivered to YPF at wellhead at $11.75 per cubic metre (about $1.87/bbl).

A local company, El Quebracho S.A., has made an undisclosed bid for two specified areas in the province of Buenos Aires.

Pan American has drilled 91 wells to contract depth; 69 were producers, 10 dry holes and others are testing.

YPF has contracts with other companies for a total of $296 million in drilling, pipeline construction, processing plants, storage, etc. Drilling contracts on the Comodoro Rivadavia area are with:

(1) SAIPEM (ENI company—See Italy) 300 wells. Forty-five wells must be completed within a year of confirmation of the contract, a further 120 in the next year and the remaining 135 in the year after. The value of the contract is estimated at $13 million, with payment at the equivalent of $6.25/ft drilled and $50 per hour spent in completing the wells. Payment will be 62% in Italian lire, spread over four years from the end of drilling of each well, with interest at 8%, and 38% in Argentine pesos about two-thirds of which will be convertible into dollars at the fixed rate of 65 to the dollar and the rest at the rate ruling at the time of payment. All the oil will be for exploitation by YPF, which will pay all taxes, but social charges will be paid by SAIPEM.

(2) Southeastern Drilling Company to drill 1000 wells at the rate of 150 in the first year of the contract, 400 in the second and 450 in the third.

(3) Kerr-McGee Oil Industries, 500 wells at the rate of 75 wells in the first year of the contract, 200 wells in the second, and 225 wells in the third.

(4) Simpson Drilling Company, 300 wells.

After these contracts were published it was decided to spread the operations over four years instead of three to ease YPF's financial obligations.

Pipelines are part of the contracts and are sorely needed to get out shut-in production. Early this year work on the 910-mile crude oil line from Campo Duran to the San Lorenzo refinery began. Next to be opened will be the 1080-mile gas pipeline from Campo Duran to Buenos Aires (to cost $193 million).

An 83-mile, 12 to 14-in. crude pipeline from Anticlinal Grande and Cerro Dragon fields to Comodoro Rivadavia began operating in March. It has a 25,000 b/d initial capacity.

Additions to refining crude oil capacity include:

YPF San Lorenzo	20,000 b/d
YPF Lujan de Cuyo	28,000 b/d
YPF Campo Duran	28,000 b/d
YPF Bahia Blanca	40,000 b/d
Royal Dutch/Shell Buenos Aires	35,000 b/d
Esso Campana	10,000 b/d

YPF plans to call for bids shortly for construction, and operation on a fee basis, of a lubricating plant and a gasoline plant. Estimated cost of the two plants is $40 million.

Important petrochemical centers are being established. One group, including Fish International Corp. (U.S.), Continental Oil, Cities Service and Witco Chemical will invest $60 million in a petrochemical plant north of Buenos Aires to produce synthetic rubber, fertilizers, and other chemicals from natural gas piped from Campo Duran and the southern Bolivian petroleum fields. Texas Butadiene also plans a synthetic rubber plant near the Comodoro Rivadavia petroleum field. In addition, Texas Butadiene plans to lay a gas pipeline and build public works costing $10.6 million.

Koppers Co. (U.S.) plans a petrochemical plant to manufacture polyethylene at La Plata.

Industrias Quimicas Argentinas Duperial and Imperial Chemical Industries Ltd. will undertake a $67.4 million expansion program in Argentina.

Ciba, S.A., of Basel Switzerland, has announced it will build a plant for the production of chemicals for the textile and leather industries at an estimated cost of $625,300.

Reserves: Crude oil, 2000 million bbl.

Consumption: About 240,000 b/d, slightly under 1958. This resulted from a rise in product prices to as much as 200% for gasoline. To keep refineries running for other products, YPF sold surplus gasoline abroad. Uruguay bought about 2½ million gallons at 9½¢ a gallon.

AUSTRALIA

(7) R. C. 220,000 b/d
Runs 217,000 b/d

Exploration in Australia is reaching a new peak. It speaks well for oil industry determination since this search has been going on since 1900 and has had little encouragement. Today's techniques, however, make a wide difference and geophysical reports have been promising. Then, too, the government is supplying some capital. But the final lure is the ready-made demand for any oil found. In Queensland alone oil leases have been obtained or applied for covering 555,000 sq miles (80% of the total land area). In addition, offshore bases totalling 110,000 sq miles have been granted.

Old hands in Australia are B P, Caltex, Stanvac, Shell, and many smaller Australian and foreign companies.

New arrivals in 1959 included: Union Oil of California, Kern County Land Company, Phillips Petroleum, Sunray Mid-Continent, Conorada, Murphy Corporation, Three States Natural Gas, Plymouth Oil, Texas American, Magellan Petroleum, and others. Phillips and Sunray recently announced joint explorations of their acreages, beginning with a seismic survey.

Companies spent about $17 million last year on exploration and the government subsidy was nearly $3 million.

There are 11 rigs in the country.

Exploration, including drilling, has been temporarily suspended by WAPET in the Carnarvon Basin, in favor of the Canning and Fitzroy Basins further to the northeast. The last hole on the Rough Range structure, No. 10, was drilled in 1957. Drilling is also proceeding in the Great Artesian Basin of South Australia and Queensland, in the Bowen Basin of Queensland and in Papua. In the Great Artesian Basin, the Delhi-Frome Broken Hill-Santos Group drilled two deep wildcats in 1959/60. Considerable geological and geophysical work is either planned or in progress in the Basin. The emphasis is on geophysics, and more attention is being paid to the Basin's substratum.

In the Otway Basin of Victoria, Port Campbell No. 1 was drilled by Frome-Broken Hill Company to 5965 ft. It had a good show of gas with a little condensate.

Two wildcats were drilled by Exoil Pty. Ltd., in 1959/60 in the Eucla Basin in Western Australia. Both holes were dry and struck granite at shallow depth.

The Australian Government has engaged the services of the Institut Francais du Petrole to give its advice on the search for oil in Australia. The Institut is an official non-profit-making organization created in 1944 to promote scientific knowledge and industrial skill in the oil industry. It is administered by a council consisting of members of industry, public servants and university professors. Funds are obtained from a levy on oil products sold in France. The Institut will work in close collaboration with the Australian Government which will be paying for their services.

Australian refining capacity and chemical industry continues to expand. Shell plans projects in New South Wales costing about $55 million. These will include: a 4½ million catalytic cracking plant at its Clyde refinery (one of the largest in the world); new port facilities at Gore Bay and a pipeline from Gore Bay to Clyde. Also, Shell Chemical (Australia) Pty. Ltd. and Imperial Chemical Industries of Australia and New Zealand plan a new petrochemical plant in New South Wales.

A contract for the engineering and construction of the key unit of a four-plant petroleum-chemicals complex, to be built at Altona, near Melbourne, has been awarded by Standard Vacuum Oil to Fluor International SA. The plant's output deriving from petroleum will include approximately 20,000 tons of ethylene a year and sufficient butadiene to manufacture some 30,000 tons of synthetic rubber. These products will be used by other units producing polyethylene, styrene and GR-S synthetic rubber. Two of these units represent Union Carbide and CSRC-Dow interest. The latter is jointly owned by Dow International and an Australian company, CSR Chemicals. The third unit, the GR-S rubber plant, is to be built by Australian Synthetic Rubber Company Ltd., a subsidiary of Vacuum.

BP in 1959 opened its lubricating oil blending plant at Spotswood, near Melbourne. The company hopes to try a new method of transporting petroleum products in a collapsible rubber tank carried on a semi-trailer truck. An advantage is that the vehicle is able to carry a return load, instead of running empty.

Consumption: 203,000 b/d inland and bunkers.

AUSTRIA

Prod. 45,726 b/d (8) R. C. 41,895 b/d
Gas 109,125 mcf/d Runs 35,002 b/d

Austrian oil production declined for the third year. It was 16% below 1958. OeMV-AG produced 94% and two private firms, Rohoelgewinnungs-AG (RAG-Socony and Shell) and van Sickle produced 6%. Gas production increased considerably. OeMV-AG owns nearly all this output.

Last year 9 geophysical groups worked in the Austrian Basin. The Staatz 1 test of OeMV-AG near Laa on the Thaya (Lower Austria), reached a depth of 11,710 ft and is Austria's deepest well. In 1959 92 wells were drilled with 67 producers. There were 21 drilling rigs active. For the first time gas was found in the main dolomite zone of the Vienna Basin.

On the basis of the obligation of the Austrian-State-Treaty 1955 the Soviet Union in 1959 was to be supplied 18,599 b/d. Russia returned 9333 b/d to Austria according to a Soviet-Austrian agreement concluded in 1958.

There are 8 refineries in operation in Austria — OeMV-AG is in charge of 4 of these (total capacity 32,915 b/d) — Shell, Mobil, van Sickle, Klederinger Mineraloelraffinerie, each own one. OeMV-AG is building a refinery at Vienna Schwechat with a 37,270 b/d capacity to be completed this year.

According to the Vienna memorandum signed in 1955 by members of the Austrian Government, USA and UK, western oil companies, Royal Dutch/Shell and Socony Mobil were to receive compensation for oil properties changed into German possession during World War II. The agreement finally worked out:

1. The Austrian government would pay $13.7 million to the two companies;
2. A new utilization company is planned with OeMV-AG holding 74% and Shell and Mobil each 13%.

In 1960 budget for OeMV-AG is higher than for 1959 — about $8 million. This is mainly for the new refinery. Less drilling is projected.

Reserves: 254 million bbl; 857 billion cu ft gas.

Consumption: 45,059 b/d, up 6% from 1958.

BAHAMAS

Standard of California and Gulf drilled one of the most expensive wells in the world offshore at Cay Sal Bank — an estimated $3,000,000. The drill went to 18,906 ft before being abandoned.

Superior drilled a well at Andros to 14,585 ft in 1946-47. The driller's log in *The Petroleum Engineer* for May 1954 (Pg B-60) reveals some of the difficulties. Superior relinquished its leases.

Concessions are held by affiliates of Sun Oil and National Oil of California.

Consumption: 1500 b/d.

BAHRAIN

Prod. 45,133 b/d (1) R. C. 186,500 b/d
Runs 190,000 b/d

The Bahrain field of Bahrain Petroleum Company (Caltex) continues to increase production, rising 11% in 1959 over 1958. About 151 wells are producing in the gas-repressured field. The company operates two drilling rigs in the area.

Besides output from the local field, the big refinery processes Saudi Arabian crude brought by a pipeline system from the mainland.

Reserves: 225 million bbl oil.

Consumption: 15,000 b/d including bunkers.

BARBADOS

Barbados Gulf Oil Company and Kerr-McGee plugged and abandoned Morgan Lewis No. 1 in the Scotland district near Belleplaine February 2, 1959. Total depth was 15,034 ft. The Gulf Oil subsidiary has been in this British West Indies island for 10 years now and this is the seventh wildcat drilled on its concessions. Several had good gas shows and Spring Vale No. 1, a low volume gas-condensate well completed in 1956, was turned over to the government-owned Natural Gas Company and is now tied into its distribution system.

Consumption: 800 b/d.

BELGIAN CONGO

Syndicat d'Etudes Geologiques and Minieres de la Cuvette Centrale are making a survey.

A new company — Syndicat pour la Recherche du Petrole dans le Bas-Congo — has been formed in Brussels for oil exploration near the mouth of the Congo River. The company is a joint venture, including Petrobelge (which will be the operator), Petrofina's Congo subsidiary, Petrocongo, and other Belgian concerns operating in the Congo. Its permit covers nearly a million acres.

Another concern, owned 72.5% by Gulf Oil and 27.5% by SYMAF, a Belgium mining firm, has a permit covering 250,000 acres offshore.

The contracts are the 50-50 profit-sharing type with government entitled to take up 10% of capital in both.

Natural gas found at Lake Kivu will not be developed at this time because of lack of sufficient markets.

Reserves are estimated at 2 trillion cu ft gas.

Consumption has risen 30% to 10,500 b/d.

Big companies go into the far corners of the world to market their oil products. Here, near the Equator and 415 miles up the Congo River from Leopoldville, a dugout canoe carries its cargo of Texaco kerosine to remote Belgian Congo villages. Photo from Texaco, Inc.

BELGIUM

(7) R. C. 155,000 b/d
Runs 135,000 b/d

An application has been made by Bataafse Petroleum (Royal Dutch/Shell) for an exploration concession over 650,000 acres in the areas between Sambre and Meuse, Famenne and Condroz. If the permit is granted the Dutch company would, probably, surrender its rights to Belgian Shell, S. A., or to another Belgian company. This must sound very desirable to a country with high consumption and no oil.

The seven refineries have not been expanded this year but Belgium still exports products.

New taxes depressed rising demand. Taxes on black oils were increased in April and on gasoline and gas oil in November. Crude oil and some oil products were added to the list subject to import license near the end of 1959.

Consumption: 119,000 b/d, up 6% above 1959.

BOLIVIA

Prod. 8736 b/d **(5) R. C. 12,400 b/d**
Gas 4378 mcf/d **Runs 6055 b/d**

The government granted exploration and development concessions to two Brazilian private firms — Petrolso de Bolivia S. A., 667,000 acres and Companhia Petrolifers Brasileira S. A., 751,000 acres. The Uniao group was granted a concession of 672,000 acres earlier.

These are in Central Bolivia, part of an area of the Bolivian-Brazilian Mixed Zone.

A large number of U. S. firms are already in Bolivia proper — Gulf, White Eagle, Standard of California, Tennessee Gas Transmission (with Union of Louisiana, Murphy, and Lion Oil), Andes (Pure, Sohio, Signal), Atlantic and others; also the Shell Group is represented. Nine rotary rigs are in operation.

YPFB, state entity, has the majority of production but is handicapped by lack of funds. Bolivian Oil Company (Fish Engineering et al) offset the Argentine Madrejones field and has one well, which tested at 2000 to 3000 b/d. The firm is currently drilling two wells.

Gulf Oil, with three rigs, is drilling the Victoria and Mitaigua areas of Central Bolivia. Gulf has temporarily suspended El Cedro No. 1 pending arrival of new equipment. The well is in the Santa Cruz area at 14,861 ft with encouraging gas shows in the Devonian. The company completed 2 wells in 1959, both dry, and 2 stratigraphic tests.

Chaco Petroleum, S. A. completed Agua Salada No. 2 as a dry hole at a total depth of 14,999 ft and is currently drilling Palo Marcado No. 1 wildcat below 8500 ft. Pure Oil has completed its geophysical reconnaissance.

The five small refineries do not run more than half total capacity, but they produce more than the demand.

Reserves: 33 million bbl oil; 27 billion cu ft gas.

Consumption: 4580 b/d.

BRAZIL

Prod. 64,657 b/d **(8) R. C. 165,000 b/d**
Gas 30,000 mcf/d **Runs 144,534 b/d**

Exploration and development of petroleum in Brazil is limited to the government entity, Petrobrás, although proposals are made frequently that outside private capital be permitted to explore unproved areas. Some private Brazilian firms, however, do hold licenses for exploration in southern Bolivia where an agreement allows Brazil some authority. Only proved area at present is Reconcavo Basin in the northeast.

As a result of the recent visit abroad of the president of Petrobrás, the Institut du Pétrole is dispatching a geological survey party to the Paraná Basin, and Petrobrás has obtained credits from ENI, valued at $20 million.

There are 46 rigs operating, including those on stratigraphic tests. Petrobrás is making an intense search of the Amazon Basin, so far with little success.

Production of 23,600,000 bbl in 1959 is an increase of 25% over 1958 output.

Petrobrás announced reserves had increased from 480 to 680 million in 1959, a 42% increase.

The 8 refineries in Brazil have increased capacity slightly in 1959. Petro-

brás has a monopoly of new capacity and receives profit for any throughput over the 1954 capacity of refineries not owned. The state company plans to build a 25,000 b/d (final 45,000 b/d) oil refinery at Santa Luzia, near Belo Horizonte. A planned 298-mile pipeline (approximately 12-in.) will transmit crude oil from Rio de Janeiro to the refinery. Estimated cost of the refinery, $99 million; pipeline, $121 million. Petrobrás plans to open a central purchasing office at Bahia.

A synthetic rubber plant of 40,000-ton annual capacity will be built soon by Petrobrás at its Duque de Caxias refinery now under construction near Rio de Janeiro.

Some Bahia production is exported (mainly to Aruba) because of its high wax content. Crude for refinery runs in Brazil are imported from Venezuela, Peru, the Middle East, and USSR.

Brazil and the Soviet have a trade agreement providing for $25 million exchange in 1960, $37 million in 1961, and $45 million in 1962. About 80% of the Russian goods will be petroleum and petroleum equipment, in exchange for Brazilian coffee principally.

Petroleum accounts for the largest imports bill — some $300 million a year.

Reserves: 680 million bbl oil, 482 cu ft gas.

Consumption: 222,421 b/d including bunkers.

BRITISH BORNEO

Prod. 112,034 b/d (1) R. C. 45,300 b/d
Gas 155,000 mcf/d Runs 44,000 b/d

All three of the Borneo territories are under British protection. Royal Dutch/Shell, the sole operator has 6 rigs in all areas.

Brunei. Seria field recovered some from the 1958 drop in production but did not reach the 115,000 b/d of 1957. All the gas is produced in this field. Only other field is Jerudong with 300 to 400 b/d output. *Orient Explorer*, mobile drilling platform, spudded offshore in August 1959. The first hole was drilled to 6280 ft and abandoned. Four wells will be drilled in this offshore area.

Sarawak. Miri field produces more than a thousand barrels daily. Offshore drilling has not been successful so far.

Only refinery in North Borneo is at Lutong, between Miri and Seria fields.

North Borneo. No oil found here but Shell continues exploration. Teikoko, Japanese company, has applied for 6 concession areas.

Reserves: 500 million bbl oil; 3 billion cu ft gas.

Consumption: 7500 b/d.

BRITISH GUIANA

In the government's 1960-64 development program $47.7 million was budgeted for geological, topographical and aerial surveys of this territory east of Venezuela.

Concessions are held by Standard of California (16,000 sq miles), which did no active exploration in 1959, and McBride Oil and Gas Corporation, San Antonio, Texas (4000 sq miles offshore).

BULGARIA

Prod. 5700 b/d(?) R. C. 2000 b/d
Runs 1500 b/d

Bulgaria's oil production is increasing — but far slower than the nation's needs. Consumption is eight to nine times recent Bulgarian crude output.

Russia has been steadily increasing its products exports to Bulgaria. In 1958, the USSR delivered 173,900 metric tons of gasoline, 166,000 of diesel fuel, 40,600 of kerosine, 21,500 of lubricants, 13,300 of asphalt and 6600 of residual oil.

Construction of a new 20,000 b/d refinery is to start this year, with initial operation slated for early 1963. This refinery, to be built with Russian equipment, "will mark the start of a modern oil processing industry in Bulgaria," according to government officials.

Oil production is concentrated in the Tiulenevo field near Shabla on the Black Sea coast about 60 miles northeast of Varna. Exploration is still under way, and Bulgarian officials say the size of crude reserves is difficult to predict. Much of Tiulenevo's production is sent to the refinery at Ruse. A "modern tube-vacuum installation" is to be built at the Ruse refinery in 1960-1961 for production of low-temperature industrial lubricants and special-purpose oils.

Consumption: 50,000 b/d.

EDITOR'S NOTE:

For information in this survey we are indebted to government authorities, to the companies operating in the various places listed, to World Petroleum Statistics and International Petroleum Trade, (Bureau of Mines, Division of Petroleum) to United States embassies in foreign countries. Information concerning all communist countries was translated from their publications and summaries written by Charles L. Adams.

BRITISH HONDURAS

The government of British Honduras has granted two oil-prospecting licenses covering 1000 sq miles each: One to Sinclair and British Petroleum Explorations Inc. and one to Standard of California. Both are in the northern area formerly under license to Gulf. Gulf and Shell hold mining leases covering 2767 sq miles.

Phillips holds 144,675 acres under 30-year-oil mining leases acquired from Gulf and an additional 1,830,317 acres are held under exploration licenses. The latter were acquired from Belize Petroleum and West Caribbean Oil in June 1958. Seismic and geological surface work on these concessions is now in progress. Altogether 60% of British Honduras and its territorial waters is now covered by leases or licenses.

Gulf and Shell's drilling program has been halted.

Consumption: 3000 b/d.

BURMA

Prod. 9500 b/d (2) R. C. 10,200 b/d
Runs 8990 b/d

To meet the country's increasing demands for oil products, Burma Oil Company (1954) Ltd. (⅔ private — ⅓ government) has tackled the problem in two ways. First, by increased drilling and reconditioning in the proved Chauk oilfield, and secondly, by intensifying its search for new oil reserves in the Irrawaddy Delta and elsewhere. Five rotary rigs were in use.

Development drilling at Chauk, in 1959, has seen the completion of 26 wells, representing a total footage drilled of 87,703 ft, and 33 old wells have been reconditioned.

Exploratory drilling in 1959 has involved about 34,500 ft of hole. At the end of the year a further Delta deep test, at Payagon, was drilled to a depth of 13,000 ft and awaited testing for production. On Christmas Eve the second deep test of the sands underlying Chauk was spudded-in and is now drilling ahead.

The Joint-Venture "1954" Company plans to return to Yenangyaung, where five or six 5000-ft wells are scheduled. The first one is on the south side of the Pin Chaung. Drilling sites complete with housing and facilities have been prepared at Irrawaddy and Yedwet. Another test drilling location at Kyun Nyogyi near Bogale is in the process of being prepared.

General Exploration Company of California has been issued a Certificate of Approval, a prerequisite for an application for an oil exploration license.

Refinery at Chauk processed 4180 b/d and the new Syriam plant had a throughput of 4810. This takes care of the major portion of the nation's demand. Under the Joint Venture agreement the government of Burma has the right to increase its share in Burma

Oil Company (1954). The other two-thirds are at present held by Burmah Oil Company, Indo-Burma Petroleum and British Burmah Petroleum, though there are indications that the proportion of shareholdings may change.

Reserves: 43 million bbl oil.

Consumption: About 8900 b/d, which is 10 to 15% increase over 1958.

CAMEROUN

(EX. FRENCH TR.)

SEREPCA (Bureau de Recherches de Petrole) is exploring this area on the West African coast which is a French trusteeship. There have been shows of oil and gas in some wells and the program is continuing with one drilling rig. One well was drilled in 1959.

Consumption: 2800 b/d.

CANADA

Prod. 506,250 b/d (42) R.C. 881,250 b/d
Gas 1,306,158 mcf/d Runs 658,738 b/d

In spite of world surpluses, Canadian production followed a rising trend. Oil production rose 11.5% and natural gas 29% above 1958.

Refining capacity was expanded in 1959 and runs increased 11%.

Pipelines, the highways for Western Canada's output, were growing. In 1959 some 2860 miles of gas lines were laid; 227 miles of crude and products pipelines. Also nearly $200 million would be spent on gas pipelines and gas plants if a breakthrough came from National Energy Board. Westcoast, Trans-Canada, and Alberta and Southern companies all plan extensive expansion in that event.

The future looks solid. Exploration continued with an average of about 14 geological crews and 63 geophysical crews in the field. At the end of the year 225 drilling rigs were active. During the year 2508 wells were drilled and 1622 are producers, 816 dry.

Refining capacity is on the upward trend. A new Irving Refining Company plant at St. Johns, New Brunswick, will have 38,000 b/d capacity and BP Canada's refinery at Ville d'Anjou, Quebec, will have a capacity of 25,000 b/d. Imperial is adding a 1500 b/d alkylation unit at Edmonton refinery and another at Sarnia.

Reserves: 3,497 million bbl oil; 26,605 billion cu ft of gas, both up from 1958.

Consumption: 829,198 b/d, up 12.6% from 1958.

CEYLON

The Ministry of Industries expects to complete negotiations soon for an oil refinery. Estimated costs of the new refinery will be about $30 million.

This will reduce to some extent Ceylon's import of petroleum products and will begin imports of crude oil in 1963.

The Ceylon budget in 1959 raised the duty on gasoline by 10¢ per imperial gallon (1.2 U. S. gallon).

Consumption: 20,000 b/d of which 50% is bunker oil.

CHILE

Prod. 17,640 b/d (1) R. C. 48,000 b/d
Runs 27,469 b/d

Of the 90 wells drilled in 1959 by Empresa Nacional del Petroleo (ENAP), state-owned company, 41 were producers. Five rigs have been operating.

Two new oil areas were added to the Tierra del Fuego fields at Punta Delgada Este and Faro Este, on the mainland, opposite the production on the island.

Since the end of 1959 one rig has been drilling directional wells at Faro Este oil field, on the mainland. Four other rigs are in operation.

Mobil International is building a 125,000 bbl blending plant at Vina del Mar.

The products pipeline from the refinery at Concon to Maipu, near Santiago, has recently been completed. There is one pump station on the 10¾-in. 74-mile line. Constructed by Cia. de Petroleos de Chile, Empresa Nacional de Petroleos and Esso, two more will be built soon to increase present capacity by 2½ times.

Reserves: 65 million bbl oil.

Consumption: 48,000 b/d, including bunkers.

CHINESE PEOPLE'S REPUBLIC

Prod. 25,000 b/d(?) R. C. 51,000 b/d(?)
Runs 50,000 b/d(?)

It is claimed in China that 916 oil exploration teams are now at work, and that 480 modern drilling rigs are in use.

China's official production figure for crude oil (including oil from shale and coal) in 1959 was 72,000 b/d, probably 25,000 b/d petroleum. This is a 57% increase over last year's claim.

Yumen field in Kansu province and new production areas in Central Szechwan, Sinkiang and Tsinghai are being rapidly developed.

Li Jen-Chun, Deputy Minister for the crude oil industry, recently was quoted in Neftyanoye Khosyaistvo to the effect that 2.26 million tons of crude oil were produced in 1958 in the oilfields near Yumen (Kansu province), Karamai (Sinkiang province), Zaidam (Kuenlun province), and in the Szetchwan province, which were all discovered after the war. He said 15 oil and gas fields were discovered in 1958.

Fuel for making chemical products in Shanghai since November 1958 accounted for 530 million cu ft of natural gas. The latter, found in large quantities in and around Shanghai two years ago, is produced from some 2000 wells.

China put its 1,000,000 metric tons per year (approximately 20,000 b/d) Lanchow refinery, the country's biggest, in full-scale operation in January 1960. The Lanchow installation is fed mainly by the Yumen field but also gets some crude from the Karamai and Tsaidam Basin fields.

In 1957, China refined about 1,000,000 metric tons of oil, indicating that capacity has now at least doubled with the Lanchow plant's first unit in full operation. Capacity of the Lanchow refinery is slated to reach 5,000,000 metric tons annually by the end of 1962.

China still gets more oil from Russia than from its own fields. In 1957 the Soviet delivered some 46,000 b/d and the amount has probably increased.

A 6000 b/d refinery has recently gone onstream at Nanchung in the Tsaidam Basin in Tsinghai province. It will process crude from Szechwan area.

Reserves: 14½ billion bbl oil.

Consumption: 124,000 b/d including oil from shale and coal — about 75,000 b/d petroleum. Imports from USSR supplied balance.

COLOMBIA

Prod. 146,778 b/d (5) R. C. 74,000 b/d
Runs 66,323 b/d

The 15% increase in production resulted largely from expansion of Colpet's Cicuco field, up more than 15,000 b/d over 1958. There were smaller increases at San Pablo, Velasquez, and Palagua fields.

In July Cities Service announced a new producing oil well with an indicated potential of 800 b/d on the Las Monas structure of the 2-million-acre El Carare area in Colombia. The well is producing from 4700 to 6372 ft.

This Colombia project is a joint venture that includes Colombia-Cities Service (as operator), Richfield Oil, and Empresa Colombia de Petroleos, the government-owned company.

John W. Mecom has developed some gas in the Tolu pool and in the Chinu pool on the Caribbean Coast which may be marketed in the future.

Geological crews worked 54 party-months; gravitymeter, 12 party-months; and seismic crews, 101 party-months.

At the end of the year 23 rotary rigs were operating, including one stratigraphic rig. Also 18 service rigs were active.

In 1959, 36 wildcats and 185 field

wells were completed. Of these 113 oil producers and 3 gas producers were completed; 17 were stratigraphic holes.

A new company being formed, will build a $6.7 million natural gas pipeline from the Cicuco oil field, Mompos, to Baranquilla. The stock will be owned 50% by Colpet (Mobil and Texaco) and Colombian Petroleum Company, the remainder by several companies in Baranquilla. The 130-mile, 10-in. pipeline will have a 20 million cf/d capacity.

Mobil International expects to construct a 75,000-bbl blending plant. Dow Chemical (U.S.) plans to manufacture agricultural insecticides near Bogota.

The bill to amend the Oil Code, and increase the government's take is being discussed by officials, including the consulting Economic Planning Board. It will be amended and if there are no Cabinet changes when Congress meets in ordinary session it will be submitted by its sponsor, the Minister of Mines and Petroleum. The bill may have some merits but its overall effects would be to reduce oil capital investments or increase costs.

Reserves: 700 million bbl oil.

Consumption: 51,000 b/d oil products, up about 6% from 1958.

COSTA RICA

The Compania Petrolera—owned in equal parts by Union Oil of California, operator, and Gulf Oil — after extensive geological studies, renewed drilling operations south of Limon. Two wells were drilled, both dry. The company was interested in the strata at a depth of 10,000 ft but mechanical difficulties were encountered. This is the only concession.

Consumption: 3550 b/d.

S. A. YEAR BOOK OUT

"The 1960 Oil Directory of Key Personnel in South America and Year Book," published by E. Ospina-Racines, has been released. There are an estimated 2500 names and titles of top personnel in oil companies, drilling contracting firms, equipment and supply companies. The directory has been prepared with the cooperation of governments and companies in the petroleum industry.

Fifteen countries of South and Central America are included. Data concerns addresses, cables, airmail, telephone, warehouses, etc. There are also complete tables of 1958 and 1959 oil operations by country. Data include: Map of oil operations for some countries, oil properties, pipelines, active rigs, footage drilled, fields, oil production, completions, reserves, consumption, runs to stills, etc.

The directory, which is $23 for one copy, can be ordered from E. Ospina-Racines, Apartado Aereo 49-45, Bogota, Colombia.

CUBA

Prod. 550 b/d **(6) R. C. 88,400 b/d**
Runs 70,000 b/d

Oil exploration came practically to a halt in 1959 under the revolutionary government of Prime Minister Fidel Castro who went into power January 15, 1959. Drastic revisions of the terms under which foreign oil concerns were allowed to operate in the country were made. In the future companies will have to pay the government 60% in cash or kind of all petroleum or natural gas produced. The government will fix initial oil production quantities and no new applications are to be granted. Extension of existing exploration concessions cannot cover more than 20,000 acres and, in future, on concessions of 2500 acres or more the operating company must drill one for each 2½ acres the first year and at least one well each year to a minimum depth of 2000 ft. The law includes no provisions for remission of income or other taxes. Apparently these will be levied in addition to other costs. These stringent terms have put an end to whatever activity might have been continued, although exploration was already on the down grade. Gulf Oil and other major companies early this year announced that they were discontinuing drilling in Cuba. There are 5 rigs reported operating in Cuba.

The new law also empowers the Ministry of Agriculture, through the Department of Mines and Petroleum, to fix annual production quotas for Cuba's refineries. The three larger plants belong to Esso, Texas and Royal Dutch/Shell.

A state petroleum company has already been set up and it will take over any concerns confiscated by the government.

Reserves: 2 million bbl oil.

Consumption: 67,000 b/d.

CYPRUS

Only activity here was some geological surveys made by Forest Oil Corporation of Bradford, Pennsylvania. This company has the only license.

CZECHOSLOVAKIA

Prod. 2200 b/d(?) **R. C. 33,000 b/d(?)**
Runs 30,500 b/d(?)

Czechoslovakia is looking to Russia, not to more domestic exploration and development, for the answer to its petroleum needs.

Last fall, Czechoslovakia became the first nation to begin actual construction on its portion of the proposed 2500-mile pipeline system to carry Russian crude from fields east of the Volga River to the USSR's eastern European satellite empire.

Initial Czech pipeline construction work was at Kralovsky-Chlmec in far eastern Slovakia near the Russian border. Czechoslovakia expects to complete the 250-mile link westward to a refinery at Bratislava in 1961.

Russian oil exports to Czechoslovakia, which has very small domestic crude production, have risen sharply in recent years. The USSR delivered 1,392,000 metric tons of crude to Czechoslovakia in 1958 compared to 379,000 tons in 1955. Russia also shipped 78,800 metric tons of gasoline and 30,800 tons of diesel fuel to Czechoslovakia in 1958. Soviet crude and products covered over 80% of Czech requirements in 1959.

In 1965, with the new pipeline in full operation, Russian crude exports to Czechoslovakia are expected to reach 5,250,000 metric tons (105,000 b/d).

Consumption: 33,000 b/d is estimate.

DENMARK

(3) R. C. 4310 b/d
Runs 4100 b/d

The Danish-American Prospecting Company, which carried out exploration intermittently without commercial success since 1938, decided to surrender its concession covering the whole of Denmark. Originally a wholly owned subsidiary of Gulf Oil, Danish-American was acquired by Jersey Standard in 1957. Gulf Oil has spent over the years about $10 million on oil exploration in Denmark, and Jersey Standard about $3.5 million. Altogether, 18 deep wells have been drilled.

Most important news in Denmark is construction of a new 20,000 b/d refinery by Tidewater Oil Company and a storage terminal on the island of Zealand near Kalundborg, 62 miles west of Copenhagen. The project is planned for completion in 1961 and will be operated by Dansk Veedol, a Tidewater subsidiary.

There are already three plants in Denmark: Dansk Mineraloliefabrik near Copenhagen takes 60 b/d crude; Kalundberg plant at Kalvandborg has a 750 b/d capacity and the A. P. Moller Maersk refinery near Copenhagen charges about 3500 b/d of Venezuelan naphtha. Products include: Ethylene used here by the Danish distilleries in the production of technical alcohol;

LPG; an olefinic gasoline blending component, plus a lean gas which is sold to the Copenhagen Municipal Gas Works for conversion into town gas.

In a trade agreement between Denmark and the USSR, the latter agrees to deliver about 10,000 b/d of petroleum products from June 1959 to May 1961. The agreement stipulates payment in convertible currencies. Earlier Danish-Russian agreements provided for trade on a bilateral basis.

Consumption: 92,644 b/d including bunkers, up 7.2% from 1958.

DOMINICAN REPUBLIC

Petrolera Dominicana, C. A., incorporated under the laws of the Dominican Republic, has under concession all of acreage within the Cibao Valley in the north, the Azua-San Juan valleys in west central and the Enriquillo Valley in the southwestern parts of the Dominican Republic, total area roughly 4,040,000 acres. Petrolera Dominicana was organized by W. D. Pawley of Miami, Florida, and stockholders are comprised of Dominican interests and an American group represented by H. S. Cole, Jr. and Son.

Petrolera Dominicana contracted with Graham-Michaelis Drilling Company of Wichita, Kansas, to carry out its 1960 exploratory drilling program. The first well, known as Kilometer 19 No. 2 was near Azua, 62 miles west of Ciudad Trujillo. This well was drilled on a closed structure mapped on surface geology. The well was spudded November 12, 1959 and abandoned on March 10, 1960 at a depth of 10,005 ft in hard, tight limestone of possible Eocene age. A second well known as Maleno No. 1-DT east of the first well is now drilling at 4508 ft.

On May 7, 1960 a Robert H. Ray Service seismograph crew started operations in the Enriquillo Valley and subsequent drilling will be carried on in that area.

Consumption: 5700 b/d.

ECUADOR

Prod. 7735 b/d **(1) R. C. 11,200 b/d**
Runs 6270 b/d

Best news in Ecuador for the year was that the government had authorized higher internal prices for products. Anglo-Ecuadorian Oilfields, Ltd., had held up operations on its refinery extensions at La Libertad until some relief was given on price ceilings. By the end of 1959 a 7700 b/d distillation unit was onstream and a 6000 b/d thermal cracker was being added.

Five drilling rigs were operating in Ecuador for Anglo-Ecuadorian and Tennessee Del Ecuador* during 1959. They drilled 28 wells of which 21 were field wells in the Santa Elena peninsula of Ecuador; 7 wildcats were dry. Exploration was carried on by 6 geological crews. California Ecuador Company (Standard of California) drilled 2 offshore wells, both of which were dry. Wells now producing total 1959 wells.

A 210-mile products pipeline is being constructed from the Port of Duran to Quito, the capital. Its capacity will be 3000 b/d products.

Present recoverable reserves: 3 million bbl oil.

Consumption: Averages 9435 b/d including bunkers.

*Subsidiary of Tennessee Gas Transmission which took over Manabi Exploration Company in January 1959.

EGYPT

(UNITED ARAB REPUBLIC)

Prod. 69,100 b/d **(3) R. C. 90,000 b/d**
Runs 74,200 b/d

A new General Petroleum Authority has been established by the government of the United Arab Republic to coordinate the petroleum policies of both the Egyptian and Syrian regions.

The organization is patterned closely on Egypt's General Petroleum Authority and should represent merely an expansion of local activities to Syria, with control over pipelines an important new addition to its power.

As part of UAR's Ministry of Industry, the body is to function as the central planning organ for petroleum policy. Principal office will be in Cairo, and two separate executive administrations will be in each region for implementing policy decisions.

Among the Authority's privileges are the right to import and export all crude oil and derivatives needed by UAR; fix selling prices of petroleum products; undertake oil prospecting, production, refining, purchase, sale, transport, and distribution operations; purchase, merge with, and annex public and private organizations carrying out work similar to its own; and advise on the granting of oil prospecting and mining leases.

Power is also given the Authority to "express an opinion" on agreements relating to pipelines passing through UAR and to share in negotiations conducted for conclusion or amendment of such agreements, and on licenses relating to pipelines and petroleum establishments in the territories of the Republic, according to the U. S. Embassy.

Considerable interest is shown in the western border areas near the Libyan discoveries and indications are the government will reduce payments here because of prospecting hazards.

Shell and BP companies (Anglo-Egyptian Oilfields Ltd., Shell of Egypt, BP (Egypt), and Shell Chemicals Distributing) seized at the time of the Suez crisis, were desequestrated April 21, 1959. Properties were returned in July and executives are working out arrangements to operate under the General Petroleum Authority.

Eight rigs are active in the Sinai and Eastern Desert areas and several new fields have been found. Largest was by COPE (government 51%, Petrofina, ENI, et al 49%) on the Sinai Peninsula. Its Sidri No. 4 came in at 5000 b/d. This is in the same area in southwest Sinai Peninsula as other new COPE fields with increasing oil output.

Refining capacity will be expanded. The government plant at Suez will add 10,000 b/d capacity and Caltex will increase its Alexandria refinery from 4000 to 10,000 b/d.

The government 1959-60 budget included $23 million for oil refineries and $12 million for pipelines. There was one report that the Soviet would probably help with an oil refinery.

Consumption: 93,100 b/d inland.

EL SALVADOR

The government has issued a decree authorizing Essosa (Jersey's Caribbean affiliate) to construct an oil refinery in this Central America country. The site being considered is in the Acajutla area.

Consumption: 5000 b/d, oil products — all imports.

ETHIOPIA

The Ethiopian Government and Gewerkschaft Elwerath agreed to an exploration concession in the Ogaden Province in Ethiopia in the spring of 1959. After two years one-half of the total area covered by the concession must be relinquished, and another quarter after four years. If oil is discovered exploitation rights will be valid for 50 years.

The Germany company began last year doing some geological mapping.

Consumption: 2000 b/d (all imports) according to Ministry of Commerce and Industry.

FINLAND

(1) R. C. 25,000 b/d
Runs 21,525 b/d

In 1959 the refinery of Neste Oy, state company, had increased capacity

to 25,000 from 23,250 b/d in 1958 and runs were up by 22%.

Consumption: Up 14% to 37,100 b/d. All crude for Turku plant was imported and products to fill demand.

FORMOSA

Prod. 90 b/d (1) R. C. 24,700 b/d
Gas 2500 mcf/d Runs 20,300 b/d

Chinese Petroleum Corporation, which has charge of all petroleum industry in Formosa (Taiwan), has diligently searched for oil since it was organized in 1946. Results have been meager. Last year saw the most encouraging discovery. A well in Chinsui field, deepened to 11,726 ft, flowed 65 b/d oil and 3,500 mcf/d of gas.

During 1959, 4 geological and 3 geophysical crews were working. The 7 rigs operating drilled 12 wells of which 1 was successful.

The one refinery processes enough for inland consumption and some products exports.

Consumption: Inland demand is 13,900 b/d.

FRANCE

Prod. 32,450 b/d (14) R. C. 760,000 b/d
Gas 252,992 mcf/d Runs 552,000 b/d

France not only has a boom going on in French Sahara but has a revival of interest in European areas. In the Paris Basin a well drilled by COPESEP (a group headed by Shell) found oil at about 4500 ft, southeast of Nogent-sur-Seine. So far out of 9 wells 8 are producing. Output is around 2800 b/d. Present total output of the Paris Basin ranges between 9000 and 9500 b/d. CEP and RAP discovered a new oil field at Chailly-en-Biere. Nineteen wells (out of 22 drilled) produce 1386 b/d.

RAP has 7 producing wells (10 drilled) at Brie-Chartrettes where March production was 378 b/d. At Villemer the company was producing 504 b/d from 4 wells. Here all wells drilled produce.

One of the best producing fields is Coulommes where PETROREP has drilled 31 wells. The 28 producers have about 4000 b/d output.

At Chateaurenard FROPEX produces 375 b/d from 4 wells. Seven wells here were dry.

In Alsace PREPA produces 980 b/d, the largest field being Scheibenhard.

Esso REP found new deposits northwest of Parentis field near Cazaux. Output is about 1300 b/d from this area. The discoveries brought a rush of exploration applications and doubled the number of geophysical crews in the field to 55. Parentis Basin continued at about 23,400 b/d rate.

SIREP found substantial deposits of natural gas at Greoux-les-Bains in the Basses-Alpes, southeast France.

A total of 238 wells were drilled compared to 180 in 1958. Of these 65 produced oil and 14 gas. There were 44 rotary rigs operating. Total producing wells in France are 460 oil and 34 gas producers.

High point of 1959 was authorization of the Marseille-Strasbourg crude pipeline, to cost an estimated $120 million. It will bring North African oil to France and German markets. Initially the 28 to 35-in. line will carry 200,000 b/d crude oil and will probably be expanded later.

Two new refineries are being built at Strasbourg, each with 60,000 b/d capacity, one by Mobil-Shell-Caltex and the other by BP-Pechelbronn-Antar. (Two new German plants are also planned.)

The operator, Societe du Pipe-Line Sud Europeen, is composed of 16 companies, among them: CFP, CFR, Purfina, BP, Antar-Petroles, Shell, Caltex, Jersey, Mobil, Gelsenberg, Scholven Chemie, Wintershall, and associates.

In Lavera, near Marseille, where the line starts, the storage area will have an initial capacity of 3,140,000 bbl, to be increased later.

New gas lines are in the planning stage. Negotiations were recently begun between Gaz de France and Societe des Gaziers de la Suisse Romande to build a branch pipeline from Dole, France, via Basle to Geneva, Switzerland. Another line is proposed by Societe Nationale des Petroles d'Aquitaine and private Spanish industrialists to transmit natural gas from Bayonne, France, to Pasajes, Spain, to supply the Spanish provinces of Biscaye and Guipuzcoa and the towns of Bilbao and San Sebastian.

A new refinery is being built at Chalons by Omnium Francaise. It will have a 60,000 b/d capacity. CFR is expanding its Gonfreville plant by 60,000 b/d. Cie Francaise du Carbon Black is to build at Bec d'Ambes, near Bordeaux, a new plant with an annual capacity of 25,000 tons of carbon black.

It has been strongly hinted that products prices might be reduced when Sahara oil begins to flow freely into France. This would be done by lowering tax, which is more than 70% of the selling price for gasoline.

In April 1960 the French Government went into the oil refining and distribution business. A state-owned company, Union Generale des Petroles, will refine oil from Sahara and sell it. The company is supposed to be a competing business without special favors from government powers.

Reserves: 188 million bbl oil; 8935 billion cu ft of gas.

Consumption: 437,866 b/d inland, up 14% from 1958, which was also 14% ahead of 1957. Including bunkers total consumption is 449,700 b/d.

FRENCH EQUATORIAL AFRICA

Prod. 14,750 b/d
Gas 3,880 mcf/d

Only two of French Equatorial Africa's four autonomous republics have been explored for oil — Gabon and Middle Congo.

SPAEF (French Government principally) is main operator. The company went into Gabon in 1949 and found heavy oil in 1955. Of the 6 producing areas discovered the biggest field, Pointe Clairette, found in 1956, produces about 5000 b/d.

In late 1958 SPAEF entered into agreements with Mobil International and Royal Dutch/Shell to obtain capital for development of its concession. Mobil's arrangement covers about 6 million acres over 2 areas in Gabon and the Congo, partly offshore. SPAEF is operator onshore and Mobil offshore.

In 1959, 18 wells were drilled by this combine and 4 found oil. A wildcat at Rembo Kotto was completed for 220 b/d of light oil and 3 others are being tested. Three rigs are operating for this venture.

The agreement of SPAEF and Shell covers about one million acres in Middle Congo. Shell will be the operating company. One field was discovered by SPAEF in 1956 at Pointe Indienne and 8 oil wells and 6 gas wells are drilled and all shut in, awaiting completion of the tanker terminal at Pointe Noire.

A total of 50 wells were drilled in 1959 in the entire area. Of these 22 are oil producers and 5 gas. This makes a total of 101 producing oil wells, including those shut in and 6 gas wells.

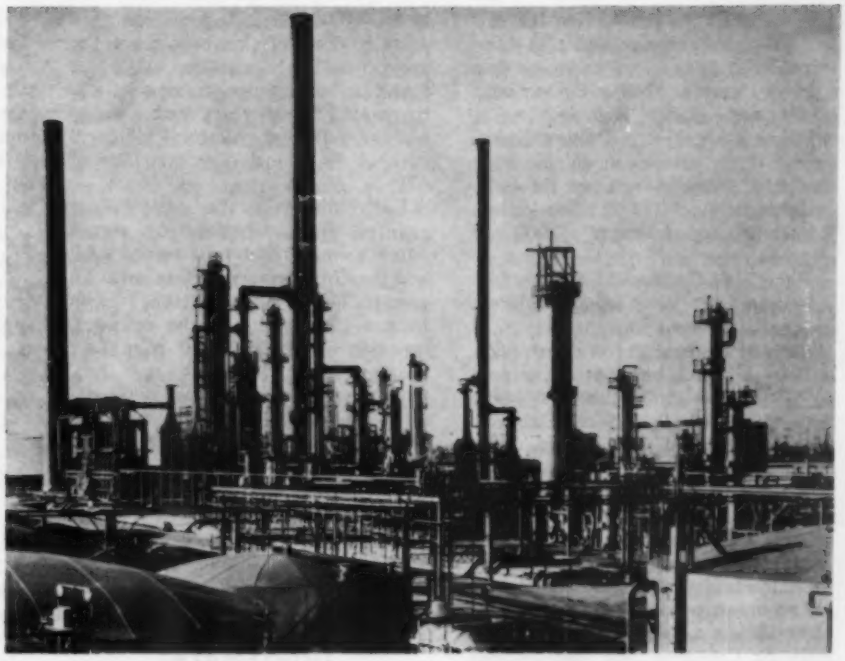
Altogether 6 rigs are operating in Gabon and Middle Congo. Cost of the oil search in these republics in 1960 is estimated at $17,500,000.

Reserves: 59 million bbl oil; 177,000 million cu ft gas.

Consumption: 3975 b/d oil products.

FRENCH WEST AFRICA

A new petroleum law was enacted in Senegal and Sudan late in 1959. Provisions of the new law are closely modeled on those of the French Saharan oil law, including the 50-50 sharing of profits; but in this case royalties will be payable at lower rates than 12½ % until production reaches 20,000 b/d. SAP, which found gas last September some 19 miles east of Dakar, has now found



Esso refinery in Cologne, West Germany. In the foreground are product tanks; in the background, the processing plants — distillation, powerformer, hydroformer. West Germany petroleum industry had an impressive record in 1959.

a showing of oil in the same locality.

Continental Oil and Cities Service made contracts in 1959 to search for oil over more than 10,000,000 acres in Senegal and Mauritania, West Africa.

In Senegal, Conoco and Cities Service joined two French companies, Societe Africaine des Petroles (SAP) and Compagnie de Participations, de Recherches et d'Exploitations Petrolieres (Coparex), in exploring the St. Louis and Richard Toll areas on concessions totaling more than 3,400,000 acres.

In Mauritania, Conoco and Cities Service are associated with SAP and the Societe de Recherches et d'Exploitation de Petrole (Eurafrep) on a concession covering approximately 7,300,000 acres.

In Senegal, Conoco will own a 25% interest in the concessions, Cities Service, 24%, and the French companies, 51%. In Mauritania, Cities Service will own a 25% interest, Conoco, 24%, and the French companies, 51%.

Societe des Petroles du Senegal (SPS) has a permit in Central Senegal, where 4 wells have been drilled, and an offshore license. SPS is owned 50-50 by French interests and British Petroleum.

Plymouth Oil has terminated further operations with SAP on the Ivory Coast. Two deep tests were dry, one abandoned this year.

In Niger, which joins French Sahara on the north, Jersey Standard has a new 9-million-acre permit.

Three rigs are operating in French West Africa and 12 wells were completed in 1959. Only 2 are producers, one oil, one gas.

Four geological and 3 geophysical crews are working.

Reserves: Too early to judge for oil; estimate 2700 million cu ft gas.

Consumption: 65,000 b/d including bunkers; inland about 12,600 b/d.

GAMBIA

(BRITISH)

Gambia is a small British possession beginning at the mouth of the Gambia River, West Africa, and extending about 200 miles inland. Only exploration license is held jointly by BP and the French BRP. Some seismic work has been going on for the last four years.

GERMANY (East)

Prod. 160 b/d **R. C. 35,000 b/d**
Runs 29,000 b/d

Strategically located at the end of both branches of Russia's proposed new 2500-mile crude pipeline originating in the "Second Baku" fields between the Volga River and Ural Mountains, East Germany will be a major beneficiary of the project.

Northern branch of this pipeline system will terminate at Schwedt on the Oder River, site of a proposed new East German refinery. Southern branch, according to new Russian maps, will reach the East German border near Dresden.

A new trade agreement signed in Moscow last November provides for shipment of more than 17 million metric tons of Russian crude to East Germany between 1960 and 1965. By contrast, the USSR sent East Germany 1,107,000 tons of crude and about 16,000 tons of products in 1958.

So far as domestic crude production is concerned, East Germany remains the poorest of Russia's European satellites, although an increase in the drilling program is reported. The 160 b/d, is a guess since figures give synthetics with petroleum. Total products output was given as 40,600 b/d in 1958.

British companies will design a 40,000 ton per year ethylene plant for the German Democratic Republic. This follows a new agreement between the two governments.

Consumption: 29,000 b/d.

GERMANY (West)

Prod. 99,000 b/d **(25) R. C. 590,000 b/d**
Gas 37,500 b/d **Runs 450,000 b/d**

The West Germany petroleum industry is marching full ahead — oil production was up 15%; gas output up 14%; refining runs up 45% and consumption up 27%. That's a fantastic record in one year.

Some 70 geophysical crews were operating and geological operations were too numerous to pin down. There are 130 rigs in the country. Of the 502 wells drilled, 337 were producers bringing total producing wells to 3700.

Refining capacity is being constructed at a rapid pace. The crude oil line from Marseilles (see France) to Karlsruhe will feed on 80,000 b/d refinery Esso has planned.

Already under construction are: BP Benzin und Petroleum plant at Dinslaken with 85,000 b/d capacity; first stage of Deutsche Shell at Godorf with 40,000 b/d capacity; Deurag-Nerag at Misburg, a 10,500 b/d addition; Erdolwerke Frisia at Emden, a skimming unit of 32,000 b/d capacity; Deutsche Erdol at Heide, a 21,000 b/d addition; Wintershall at Salzbergen, a 2000 b/d addition.

Rheinische Olefinwerke brought into operation a new plant using a different process to produce polyethylene.

Besides the pipeline from Marseilles, a 28-in. crude oil line from Rotterdam to Wesseling — 183 miles — is being laid. A third one from South Hanoverian oil fields to Misburg is under construction.

A German-Italian pipeline company, the Suedoel A.G. fuer Erdoelwirtschaft, will build an oil pipeline from Aigle (Switzerland) to Munich, with a branch line planned from Munich to Offenburg or Stuttgart. Construction of the Genoa-Aigle section, with branch lines to Cremona and other Italian cities, was started in May by Italian ENI. The entire system is to be constructed by 1962. Construction costs for the Genoa-Aigle section are estimated at $32 million and from Aigle to the German terminals, another $25 million.

Esso A.G. and Duetsche Shell A.G. are reported planning an oil pipeline from the Mediterranean to Bavaria.

A consortium of four large producers of oil and natural gas, Preussag, Gewerkschaft Elwerath, Wintershall, and C. Deilmann, plan to build a gas pipeline from Bentheim in Emsland to Dorsten in the Ruhr, Germany, a distance of 53 miles. The pipeline, which will have a capacity of about 70,000 mcf/d will cost an estimated $2,600,000.

Reserves: 550 million bbl oil; 500 billion cu ft of gas.

Consumption: 462,130 b/d.

GHANA

An aerial geophysical survey covering 4800 sq miles has been planned by the Ghana Government and U. S. International Cooperation Administration, the cost being shared.

Consumption: 850 b/d oil.

GREECE

(1) R. C. 30,000 b/d
Runs 30,000 b/d

Esso has entered a contract with the Greek Government for exploration and development rights in the region of the Paxi and Zakynthos Islands off the southwest coast, as well as near Killini and Pylos in western Peloponnese. The company will have to spend a minimum of $6,400,000 and, if at the end of 8 years no discovery has been made, the areas will be relinquished. If oil is found an exploitation concession will be granted for 30 years, with a possibility of a 10-year renewal. Profits will be split 50-50 including a royalty of 12½%.

Early this year the government granted an oil exploration permit jointly to the French state-owned RAP and the Greek company Ilios, over an area in Thrace adjoining the Turkish frontier. RAP will be the operator, investing about $950,000 over four years.

Others who have ventured in Greece were Deilmann Petrol (German and Turkish); W. G. Helis, and American Grecian Oil Company.

The refinery at Aspropyrgos is running almost at capacity. Operator is a local company, Oil Transport, Trading and Refining Company. Some expansion is planned.

Consumption: 37,500 b/d.

GUATEMALA

For the first time some oil was encountered in this Central American country. Chinaja No. 1 test in Peten

produced the first sample in July but oil was not in commercial volume. The wildcat was drilled to 10,806 ft and abandoned after high pressure and corrosive sulfur water flow and periodic circulation loss caused drilling pipe to part 3 times in 8 months. In March this year 38 joints of pipe weighing 25,000 lb dropped 2400 ft to bottom of well.

Ohio Oil, operator, and its associates, Amerada, Conoco and Union of California, decided to move the rig about 18 miles further in the jungle and drill a second hole.

Atlantic is drilling east of La Libertad, also in the Peten. It is operator for a group composed of Union of California, Standard of California, Standard of Ohio, and Tidewater.

Standard of California drilled to 8500 ft at a location near Livingston, north of Rio Dulce, in 1959.

Coastal Plains Oil and Gas Company (formerly Sloan Exploration) drilled a dry hole near Lake Izabal in 1958.

Shell and Breaux Bridge Oil Refinery Company expect to complete the 4000 b/d plant on the Caribbean Coast. Lummus Company, the contractor, is pre-constructing much of the plant and shipping in packaged units. A new firm, Refineria Metias de Galves, will operate the refinery.

Consumption: 8800 b/d.

HAITI

Commonwealth Oil Company, Houston, Texas, drilled one dry hole during 1959, Cul-De-Sac No. 1, near Port-Au-Prince. It has the only concession so far but it has been rumored that concessions have been applied for by other companies.

Consumption: 1200 b/d oil products.

HAWAII

(1) R. C. 3000 b/d
Runs 2800 b/d

Further expansion of the Hawaiian refinery now being built near Honolulu is planned.

New equipment, supplementing that already under construction, will include a 13,000 b/d fluid catalytic cracker and alkylation plant for manufacture of high octane gasolines and aviation fuels, hydrogenation, and isomerization units for processing specialized products and feed stocks; a carbon monoxide boiler, dust precipitator and sulfur recovery equipment to assure complete pollution controls; additional tankage for storage of products and crude oil, and numerous other utilities.

Erection of these new facilities will provide the Mid-Pacific area with its first complete petroleum processing plant and will nearly double the company's original investment of approximately $33 million in the Hawaiian refinery.

Construction of a crude still, treating plants, pipelines, tanks, marine loading facilities and laboratory-office buildings has been underway for over a year at the 300-acre Barber's Point site and will be completed by October 1960. The additional equipment is expected to be on stream by the middle of 1962.

Capacity of the refinery will be approximately 32,000 b/d.

More than 400 Islanders are currently at work building the plant and over 200 will ultimately be employed in the refinery.

Consumption: 38,600 b/d.

HONDURAS

Petroleos Hondurenos S.A., composed of U. S. independents and local interests, has an 11 million-acre permit and Compania Petrolera Hondurena has a 48 million-acre permit. A geology

study is being made by one field crew under Richard A. Mills, manager of Petroleos Hondurenos S.A. Drilling is to begin this year.

Consumption: 3000 b/d.

HUNGARY

Prod. 20,000 b/d (5) R. C. 38,000 b/d
Gas 13,000 mcf/d Runs 35,000 b/d

Oil production that Hungary lost during and immediately following the anti-Communist uprising of 1956 is still far from being regained, but it is getting closer to the 30,000 b/d output in 1955.

The Soviet satellite, however, has high hopes of boosting domestic production in the future due to "positive results" achieved in recent geological exploration of the Great Hungarian Plains, where more than 800 wells were drilled in 1958 and activity continued high last year. Hungary hopes to boost crude production to 1,100,000 metric tons in 1960, compared with 674,000 tons in 1957 and 1,601,000 tons in 1955 before the revolt. A new economic development plan for the 1961-1965 period calls for doubling crude production and tripling natural gas output. Hungary's section of the proposed 2500-mile crude pipeline system originating in Russia's Volga-Ural fields is slated for completion in this period.

Hungarian imports of Russian crude reached a record 1,085,500 metric tons in 1958 (last year for which complete figures are available), compared with only 200,300 tons in 1955 before the revolt. Products imports from Russia in 1958 were small: 52,400 metric tons of residual oil and 3200 tons of lubricants. More than balancing these were Hungarian exports of 64,600 metric tons of oil products (including synthetic) to the Soviet Union in 1958.

A new 60,000 b/d refinery is to be built 15 miles south of Budapest. Building is due to be undertaken as part of the Second Five-year Plan 1961-65.

Reserves: 175 million bbl oil.

Consumption: 39,000 b/d oil products; 13,000 mcf/d natural gas, all production.

INDIA

Prod. 9,900 b/d (4) R. C. 112,286 b/d
Runs 110,000 b/d

The Indian Government has decided to invite foreign companies to join in the search for oil in India. The government intends to continue rapid exploration of oil-bearing areas in which it is already actively engaged but a large-scale oil exploration program involving substantial expenditures of foreign money in a comparatively short time must be undertaken if India is to attain its target of producing 14 million tons of crude oil by 1966.

Recent explorations have shown some 400,000 sq miles of potential oil-bearing areas spread over many states. Rules under the new policy of granting exploration licenses to foreign firms provide a term of four years, with renewals every two years. The area covered will usually be 3000 sq miles per firm.

A booklet entitled "Oil Prospects in India" has been issued by the Indian Ministry of Steel, Mines, and Fuel, New Delhi. It includes the new rules and a brief review of possible oil-bearing sedimentary basins in the country. A copy of the booklet is available on loan from the Far Eastern Division, Bureau of Foreign Commerce, U. S. Department of Commerce, Washington 25, D. C.

Previously the government participated in all exploration. It has 25% of the Indo-Stanvac search in West Bengal where the company drilled two dry tests this year and kept two geophysical crews at work.

Following the launching of Oil India Private Ltd. (Burmah Oil/Assam Oil ⅔; government of India ⅓) the new oil areas of Nahorkatiya and Moran, in the Brahmaputra Valley of Upper Assam, are being developed by that company. From June 1953, when the Nahorkatiya field was discovered by Assam Oil, through 1959, 63 wells had been completed at Nahorkatiya, Hugrijan and Moran. Most of the wells were established as good producers. Two gas wells at Nahorkatiya are among the completions. Assam Oil announced that gas turbines will be employed for the first time in India to generate power and light at Nahorkatiya using gas from the oil fields there.

Both fields are shut-in awaiting a pipeline system and refinery outlets. The government of India will build new refineries to operate on Assam crude produced and transported to them by Oil India. The first plant will be at Gauhati in central Assam some 270 miles from Nahorkatiya, and the other at Barauni in the state of Bihar, a further 450 miles to the west.

The Oil and Gas Commission, a government agency, found oil in the West in 1958, and now, with Romanian technical aid, this Cambay area (near Bombay) is being developed.

Under the Indo-West German Technical Assistance program, a German team will make a geophysical survey and train Indian assistants in geophysical techniques. Except for local expenses the cost, including equipment, will be borne by the West German Government.

Altogether 8 rotary rigs are operating in India.

USSR has granted India a credit of some $25 million to be repaid over a long period, for the construction of the state-owned refinery at Barauni in Bihar. This will be the second state-owned refinery to treat oil from the Nahorkatiya area. The first, at Gauhati in Assam to be completed in 1961 will be designed, and the construction supervised, by Romanian technicians. Indian technicians will be trained in India and in Romania in refinery design and operation. The Romanian Government will receive $11 million for equipment and services over a period of 5 years.

Construction of the pipeline from the oil-producing areas to these refineries began late in 1959. Burmah Oil will provide $28 million for construction of the first stage. The total cost is estimated at $111 million. Length: Nahorkatiya to Gauhati (Assam), approximately 260 miles of 16-in. line; Gauhati to Barauni (Bihar) 470 miles of 14-in. pipe, a total of 730 miles.

Imperial Chemicals Industries (India), a British firm, plans a fertilizer plant, at Visakhapatnam using waste gases from the Caltex Oil Company refinery there.

In November the Ministry for Mines and Oils announced that there would be a total net reduction at the rate of about $39,900,000 a year in prices received by oil companies for major petroleum products as a result of negotiations with the companies. Consumer prices of the products will remain unchanged.

Reserves: 200 million bbl oil.

Consumption: 133,300 b/d inland; bunkers 7500 b/d.

INDONESIA

Prod. 367,064 b/d R. C. 278,800 b/d
Gas 330 mcf/d Runs 273,200 b/d

Sumatra	343,337	(82,000 (114,000)	77,200
Borneo	18,549	75,000)	
Java	5,178	7,800)	196, 10
Total	367,064 b/d	278,800 b/d	273,200 b/d

Everything looks up in the Indonesia petroleum industry. Production rose 9%, refining capacity 10% and runs up 17% for the year.

But advances were made in spite of political uncertainties, the threat of a new restrictive oil code and the low price ceiling on petroleum products. Until the new code is legalized there is little use of speculation.

In 1959 prices virtually doubled on oil products but the larger portion of the increase went to the government in taxes.

Many promising projects are underway in this Republic of islands. Royal Dutch/Shell (BPM) has begun a 160-

This map from *Shell News* makes Indonesia operations more understandable. The northern fields are those which the Japanese are negotiating to operate.

mile, 20-in. pipeline from its Tandjung oilfield in South Borneo (Kalimantan), to its refinery at Balikpapan on the coast. This crude is highly paraffinic and to avoid heating it along the line it will be pumped in suspension with about 30% of water. Construction of the pipeline will take about three years. Cost to develop field and complete pipe is estimated at $65 million.

Caltex is developing its new Sumatra fields, Duri and Bekasap, and recently made a discovery at Pematang in Central Sumatra. A recent brochure on "Indonesia" published by Caltex shows it has a $140 million investment in its holdings here.

A fertilizer plant will be built at Palembang, Sumatra, by the government with a $33,200,000 loan from the Export-Import Bank of Washington. Raw material used will be natural gas found abundantly in the area. The Indonesian Government has signed a 20-year agreement with Standard-Vacuum for the supply of 5000 million cu ft a year of natural gas from its South Sumatra fields. The plant will have an annual capacity of 100,000 tons, and be served by a 60-mile pipeline to be built by Stanvac.

During 1959 Stanvac made one discovery out of 11 tries and drilled 29 development wells, 21 producing.

Last report on rigs was 28 on all islands.

A state-owned company, Permia — which holds fields and a refinery of Royal Dutch/Shell in North Sumatra —is negotiating with Japanese to assist in operating the properties. Actually the Japanese took these over during World War II and they have been inoperable until recently. Present output is about 10,000 b/d. Idea is for the Japanese to supply $50 million for developing the area and take payments out of oil.

Consumption: Inland 57,600 b/d; bunkers 15,100 b/d.

IRAN

Prod. 923,000 b/d (3) R. C. 492,000 b/d
Runs 365,900 b/d

Present operators in Iran are:

1. Iranian Oil Participants, Inc. (IOP) made up of BP (40%); Shell (14%) and 15 others with small interests. Took over BP's concession under agreement with the government in 1954. Has practically all operations at present.

2. Iran Pan American Oil Company (IPAC), made up of Pan American (Standard Indiana) and National Iranian Oil Company (state owned), has 6176 sq miles offshore in Persian Gulf. Is now drilling first test.

3. Iran Canada Oil Company (IRCAN), Sapphire Petroleum and NIOC, has 386-sq-mile concession off and on shore.

4. Societe Irano-Italienne des Petroles (SIRIP) is ENI, Italian state-owned company, and NIOC. The concession 8839 sq miles is along North shelf of Gulf on eastern slope of Zagros Mountains (where first wildcat is located) and on coast of Gulf of Oman.

A total of 15 drilling rigs are in use by all companies.

The government company, NIOC, has a drilling program going on its concession in North Iran with 6 rigs in operation. Saradjeh, a new productive area, is reported by NIOC Chairman Abdallah Entezam, to have already found proved reserves of 400 million bbl oil and nearly 8 trillion cu ft gas.

Iranian Oil Exploration and Producing (Iranian consortium) has 7 rigs operating. In 1959 11 wells were drilled, one dry, making 89 wells which produce 923,000 b/d. Two geological parties and 3 geophysical crews searched for new structures.

Geological parties completed work in the Buzpar-Bushgan area south of Kazerun and on structures in the Bandar Lengeh area. They are now working in the Seh Qanat area east of Gach Saran, and the Kuh-Safid area in Dashtestan. The land gravity survey was completed. Preparations for the marine gravity survey are underway. A topographic survey party, with helicopter support, started activities in the Gach Saran area. Similar work continues in the Ahwaz, Abadan and Bandar Mashur areas.

Agha Jari Well No. 57, which was spudded in August 1959, was completed as a producer well in the second half of December. Capacity of the well is estimated at about 30,000 b/d.

Iran Refining (consortium) operates Abadan (potential capacity 412,000 b/d) and the Masij-i-Salarman topping plant (75,000 b/d). Only other refin-

ery is NIOC's Kermanshah plant (5000 b/d).

A major addition to the facilities at Abadan refinery will be made by the construction of a catalytic reformer with a capacity of 20,000 b/d. The new plant will produce high octane components for manufacture of premium quality motor gasolines. It is estimated that the expenditure for this project will amount to about $10 million. The design and construction is expected to take two years.

International Marine Constructors (U. S. Collins) is working on the longest, deepest and largest diameter "pulled" submarine pipeline—the one from Gach Saran field to Kharg Island. The crude line, 26/28/30-in. and 99 miles long is being pulled along the sea bed.

An 8-in., 240-mile product pipeline from Teheran to Shahrud in northeast Persia is to be built for NIOC by Williams Bros., Tulsa, Oklahoma. With one pumping station, initial capacity will be 10,000 b/d to be expanded later to 15,000 b/d. Shahrud will be the center for distribution of products in the Khurassen Province.

Work is progressing on the 140-mile, 10-in. natural gas pipeline which is to supply gas from the Gach Saran field to industries at Shiraz. Societe Entrepose and Costain-John Brown have begun construction on the first section of the line between Shiraz and Marvdasht.

A fertilizer plant is under construction at the latter town, which is 25 miles north of Shiraz. Extension of the pipeline from Gach Saran to Shiraz will probably be completed in 1960.

NIOC plans to bring natural gas to Teheran from the newly discovered Sarajeh field near Qom, as well as Sarajeh oil for refining, and to sponsor a petrochemical industry to use gas now being flared.

Reserves: 35,000 million bbl of oil.

Consumption: 55,000 b/d inland; 101,000 b/d including bunkers.

IRAQ

Prod. 849,307 b/d (6) R. C. 55,830 b/d
Runs 40,000 b/d

Of the exploratory wells drilled in 1959 none were commercial. In the Bai Hassan field, west of Kirkuk, well No. 13, however, found a new oil sand. Initial production capacity is 2000 b/d.

A drilling contract was awarded Keir and Cawder Arrow Drilling (U.K.) to start operations for Basrah (IPC subsidiary) in Rumaila field. Heavy drilling equipment, including two rigs capable of drilling to depths of 12,000 ft, was imported into Iraq. The first two wells were spudded-in during October. This brings rigs in the country to 12.

Production increased by 17% over 1958 and the government would like greater output. General Karim Kassem, in power since 1958, has retained the 50-50 agreements. Iraq General Oil Commission has taken over the interests of Khanaqin Oil Company (BP) which included Naft Khaneh field, discovered in 1923. The government also took over distribution from Khanaqin.

Pipelines now in construction will push productive capacity. Work continued during the year on IPC construction of looplines paralleling the 30-32 in. Kirkuk-Mediterranean pipeline. By the end of the year work was approaching completion on a 20-mile section toward Banias Terminal. Construction of this loop will complete the 306-mile length of new pipeline between Banias and the Iraq/Syria border. From 494 miles in Syria a 38-mile loop was under construction toward Tripoli, Lebanon. This loop parallels the 12 and 16-in. lines which terminate at Tripoli.

A contract has been awarded for construction of an additional 314 miles of 30-32-in. pipeline in Iraq. In northern Iraq 249 miles will be laid between Kirkuk and the Syrian border. The remaining 65 miles of line will be laid between Zubair and Fao in southern Iraq. The contract has been awarded to Turriff-Burden, Ltd., of London. This pipeline project is part of the development program to expand capacity in Iraq to a rate of 1,150,000 b/d by 1962.

Basrah Petroleum Company has agreed to supply Rumaila gas to the government powerplant and a proposed fertilizer plant. The gas will be piped to the eastern end of Rumaila field where the government plans to lay a pipeline to the installation. The project will cost about $364,000.

In 1959 the Iraqi Government received $240 million in revenues from Iraq Petroleum Company and its two associates, an increase of $18 million over last year.

Reserves: 25,000 million bbl.

Consumption: Inland consumption is about 25,000 b/d; bunkers, 620,000 b/d.

IRELAND

(1) R. C. 40,000 b/d
Runs (avg) 490 b/d

Ambassador Irish Oil, subsidiary of Ambassador Oil Corporation of Texas, has been granted exploration rights over all Ireland and its territorial waters for a five-year period with privilege of extension for five years at a time upon relinquishing 25% of the original area. The company must drill a 5000-ft well and must spend $300,000 in three years. Terms are very liberal but prospects are considered rather poor.

The first major refinery built in Ireland, at Whitegate, County of Cork, was completed by Shell-Mex and B. P. (40%), Esso (40%) and Caltex (20%). With a capacity of 40,000 b/d, the refinery will supply virtually all requirements of the Irish Republic.

Consumption: 20,272 b/d for inland demand and 2872 b/d for bunkers.

ISRAEL

Prod. 2,526 b/d (1) R. C. 83,000 b/d
Gas 219 mcf/d Runs 30,000 b/d

Each of the 7 companies with exploration permits is doing surface work. Two seismic crews and one gravity party are in the field.

In 1959 the 7 rigs operating drilled 6 wildcats, all dry, and 4 development wells, 3 gas and one oil. This makes a total of 22 oil and 5 gas.

A 2-year drilling program costing about $8 million is planned by Lapidoth Oil Prospectors to include new wells to the north of the company's Heletz field.

Potential yield of gas from four wells at Zohar in the Negev, southeast of Beersheba, is estimated to be 5 million cu ft a day. Naphtha Petroleum, representing Israeli and foreign interests, will drill further wells in the Zohar gasfield. A 20-mile, 6-in. pipeline will be built from this field to the Dead Sea Potash Works at Sodom. It will cost about $2 million.

An agreement was signed in Jerusalem July 17, 1959, between the government and a group of local and foreign companies headed by Baron Edmond de Rothschild giving the group a 49-year lease on the pipeline from Eilat to Haifa. The line now consists of 8-in. pipes from Eilat to Beersheba and 16-in. pipes from Beersheba to Haifa. Under the agreement the government will replace the Eilat-Beersheba line with a 16-in. one, raising its present capacity of 1.7 million metric tons annually to 2.9 million tons by March 1961 and ultimately to at least twice that volume.

The government will guarantee rates for the transport of oil affording a minimum net income of 8% on the company's investment of $24 million. This is the largest single new investment yet made in Israel by a foreign group.

The Alliance Tire & Rubber plans an $8-million synthetic rubber plant in Tel Aviv.

Reserves: 20 million bbl oil; 30 billion cu ft gas.

Consumption: 33,950 b/d, up 11%.

Global Notebook

ITALY

(SICILY-TRIESTE-SARDINIA)

Prod. 36,000 b/d (36) R. C. 595,000 b/d
Gas 500,800 mcf/d Runs 591,624 b/d

There is some difficulty in assembling statistics for the Italian petroleum industry because some figures are for one section and others cover all. Sicily and Italy have different exploration and development codes, for instance, but the Italian Constitutional Court has ruled that refinery projects in Sicily require the consent of the Italian Government and that the Sicilian Regional Government is not authorized to grant permits.

A new Sardinian Code has been set up similar to Italy's. Prospecting permits, to be given only to Italian nationals or companies registered in Italy, are valid for three years and can be twice extended, each time for three years. Concessions are for 20 years, and can be renewed three times for 10 years on each occasion. Normally, the maximum size of a permit is 250,000 acres and of a concession 12,500 acres with the further provision that the total to be held by one permit holder and by one concessionaire must not exceed 375,000 acres and 200,000 acres respectively, but the areas are doubled if the permits or concessions are held by an entity in which either the Italian state or the Sardinian region has an interest of at least 30%. There is a graduated scale of royalties, ranging from 1% on the first 750 bbl of crude produced in a month, to 25% in excess of 30,000 bbl a month.

An exploration permit covering the western half of Sardinia is held by a company in which the Regional Government participates together with the German company Wintershall.

Italy. The unfavorable oil law of 1957 shut out exploration on the mainland by Gulf, Shell, Esso and BP. Ente Nazionale Idrocarburi (ENI)*, state-owned concern, was left with exploration rights in the north. AGIP Mineraria, belonging to ENI, and the Yugoslav Petroleum Association have agreed to set up a joint commission of experts to study the possibility of cooperating in oil exploration work in the Adriatic Basin.

In the south Pan American (Indiana Standard) and Cities Service have now obtained, through joint subsidiaries, 14 exploration permits, covering 923,000 acres in the southern part of the Italian mainland. Applications for further permits are pending. The first test well is expected to be spudded-in soon.

In this same area in Lucania AGIP Mineraria discovered a gas field with an estimated 350 billion cu ft reserves. Gas was also found at Pomarico.

These finds and increased production of some 6 to 7% over 1958 have given Italy new confidence in its natural gas industry.

ENI has 32 drilling rigs operating. In 1959 the state entity drilled 152 wells, bringing in 74 producers.

Sicily. With its own more inviting prospecting laws, Sicily has a number of companies operating. Gulf, which found the Ragusa field, Edison of Italy, ARPE (Esso and Italian firm), Getty, Macmillan are among those interested in the island, as well as ENI which found the second largest field, Gela. BP gave up its concession recently.

The first French participation in the Sicilian oil search covers an agreement for joint exploration between Petropar, (BRP 60%) and SIT, a member of the Italian Edison group.

The German (partly state-owned) Preussag has acquired four exploration concession areas, totaling 230,000 acres in Sicily, two of them near Palermo, and two in central Sicily to the north of the Gela field. Geophysical work has begun.

Sicily produces about 34,000 b/d of the total Italian oil output. Highlight of 1959 was discovery in June by ENI of production about a mile offshore from Gela. It had a 1500 b/d potential.

Gulf Italia had 3 drilling rigs operating on the island in 1959.

Sicily has two refineries, RASIOM's 100,000 b/d plant at Augusta and AGIP's 2500 b/d refinery at Gela. ENI plans to erect a large "coking" plant capable of treating 60,000 b/d of oil from the Gela oil fields, and a refinery-petrochemical complex to cost $160 million in Gela on the south coast of Sicily.

Trieste has two refineries also: Aquila Societa Technico-Industriale (25,000 b/d) and Esso Standard Italiana (6000 b/d).

Other refining plants are on the Italian mainland. Shell Italiana is expanding the Condor refinery it purchased in 1959 to 50,000 b/d capacity.

Columbian Carbon Company is going to build in the Milan area a carbon black plant with an output capacity of 60 million lb annually, for the supply of the European Economic Community countries. The plant is expected to be in operation early in 1961.

ENI is constructing a crude oil line from Genoa in the Po Valley to Aigle, Switzerland, and Munich, Germany.

SAROM plans to construct a products pipeline, approximately 150 miles in length, to connect its refinery at Ravenna to Milan, with capacity of 20,000 b/d.

The Montecatini group (PETRO-SUD) of Milan plans to construct a 62-mile natural gas pipeline from Dellino-Attanasio (in Terano Province, Abruzzi Region) to the Adriatic Coast. The pipeline will serve small industrial users and a petrochemical plant which the Montecatini industrial group plans to build. Cost of the whole project is estimated at $95,000,000.

Italy's new trade agreement with the USSR provides for Russian deliveries of 2,500,000 tons of crude oil and 650,000 tons of fuel oil during 1960. Under an agreement signed with the Russian state organization Techmachimport, Montecatini will supply the USSR with technical details concerning the production of petrochemicals, including ethylene, acetylene and maleic anhydride. Equipment required for these production processes will be supplied to the USSR by Italian firms.

The future looks promising to ENI, which has been allotted $165 million for investment in 1960.

Reserves: 300 million bbl crude oil.

Consumption: Inland demand at 293,000 b/d is up 25% over 1958.

*ENI is a remarkable agency under the direction of a remarkable personality, President Enrico Mattei. Its "Annual Report and Statement of Accounts" for 1958 reports that the complex organization operates in many other countries, sometimes associated with other firms, sometimes with the government itself — as in Iran and Morocco. President Mattei stated ENI made 12½% of the endowment fund it received from the Italian government. Most companies would be pleased with this profit on invested capital.

JAMAICA

Oil prospecting operations are to be undertaken both on the island and on the Morant and Pedro Banks by Time-Jamaica Petroleum (affiliate of Time Petroleum, Wichita, Kansas) under an agreement recently entered into with the government covering 8000 sq miles. Under the terms of the concession, 14 months will be expended in geological and geophysical work, particularly on the definition of the large structures on the north and east coasts as well as the salt dome areas of the south coast.

After the 14-month geological/geophysical program, five wells will be drilled, one of which is scheduled for 15,000 ft and the others will probably be about 6000 to 8000 ft.

Construction of the 26,000 b/d Esso refinery will begin this year and is expected to be completed in 1962.

Consumption: 23,000 b/d oil products.

JAPAN

Prod. 7,272 b/d (23) R. C. 638,308 b/d
Gas 46,422 mcf/d Runs 347,366 b/d

Petroleum Resources Development Company has brought in the first successful offshore well to the west of Akita, in the Sea of Japan. A LeTourneau platform was used for SK-1, a lit-

tle more than a mile offshore. Production tested 124 b/d from 1775 to 1908 ft. Total depth was 4760 ft.

An exploratory well of Teikoku Oil Company in Niigata prefecture has been yielding over 17 million cu ft a day of dry gas, compared with an average of only about 53 mcf/d for other wells producing dry gas in Niigata. Before this discovery total production of gas in Japan amounted to about 40 cu ft a day of dry gas and 1413 mcf/d of casinghead gas.

These are heartening signs for bustling Japan, which needs more and more petroleum for its industrial progress. The government is backing intensive exploration and encouraging investment in outside reserves. The Iran venture and the Indonesian negotiations are evidences of the search for crude oil resources.

The Ministry of Trade and Industry has been studying a plan to raise from the present 2% to 10% the import duties on crude oil to help the depressed Japanese coal industry. (This should strike a bell in the U.S.)

About 10% of Japanese exchange is required for oil imports. One trade agreement is with the USSR under which Japan is committed to import a total of 1,250,000 bbl this year.

In 1959 140 wells were drilled. Although oil output was only a slight 3.6% higher, natural gas jumped 30% to 46,422 mcf.

Japan's sharp increase in demand—18% in 1959—has spurred refinery development. At present capacity of the 23 refineries is only 54% in use but building goes on. Here are those in progress at Kawasaki, near Tokyo:

1. General Sekiyn 35,000 b/d plant.
2. Indemitsu 50,000 b/d refinery.
3. Nichimo Oil 15,000 b/d refinery.
4. Toa Nenryo (Stanvac 55%) 12,000 b/d refinery at Goi.
5. Maruzen Oil 60,000 b/d at Mizushima.
6. Mitsubishi Oil (Tidewater 49%) 40,000 b/d refinery.

The petrochemical industry has made rapid gains with government encouragement in the form of tax exemptions, etc. In a short three years the business has gone from scratch to a dozen plants. The new gas discoveries will help the petrochemicals greatly.

Latest plant is that of Furukawa Chemical Industries of Tokyo, brought onstream late last year. It makes polyethylene and copolymer plastics by a new low-pressure process developed by Indiana Standard. The particular feature of this process, of which Furukawa is the first foreign licensee, is that it permits production in a single plant of a wide variety of plastics, ranging from typical rigid polyethylene to copolymers having a density comparable to conventional high-pressure polyethylene.

Reserves: 30 million bbl.

Consumption: Domestic 310,839 b/d up 18% over 1958. Gas demand, same as production.

Another Retroactive Invention

Russia has completed Caspian Sea tests with "original" rubberized nylon bags for transporting crude oil and products.

The towed vessels, similar to those already used in the free world, will be employed this year not only in the Caspian Sea but along the Volga River and several other Soviet waterways. The bags have been found especially suitable for shallow areas of the Caspian and the Volga River estuary, which cannot be navigated by large tankers.

Soviet reports say that after being emptied, the bags will be returned to the supply point by truck, airplane or ship.

Izvestia

JORDAN

Phillips Petroleum, which already had acquired operating rights over one-third of Jordan from E. W. Pauley, was awarded a new concession in the Dead Sea area of about 4½ million acres, another one-third. It recently spudded in its sixth test, this one on the new concession near Karak. Phillips will pay Jordan $6000 besides the $75,000 annually already agreed to.

The Oil Refinery Company (part government-owned) is completing its 6500 b/d refinery near Amman and is conducting studies for laying products lines to the principal cities in Jordan.

KENYA

BP-Shell Petroleum Development of Kenya Ltd. completed its shallow stratigraphic drilling program near Lamu, and carried out extensive seismic prospecting in the northern part of its main license area, east of Garissa and Bura. The company in May took out a second oil exploration license over an area of 9500 sq miles, and made a preliminary geological survey of the area.

The Frobisher Company continued geological work on its license area in northeast Kenya.

An oil exploration license was taken out by N. M. Mehta over an area of 5820 sq miles in the southern tip of Kenya, between Voi and the boundary of the BP-Shell license area. Preliminary work only was carried out during the year.

Shell and BP signed an agreement with the government for the construction of a 22,000 b/d oil refinery in Mombasa. Estimated cost of the project is $45,000,000. A new railway spur will be required from the refinery to Changamwe, and a new oil berth, designed to accept tankers of up to 70,000 tons capacity, will be constructed. The refinery will serve Kenya, Uganda and Tanganyika, where total consumption in 1959 was 1,170,000 tons, including bunkers.

At present East Africa is supplied mainly from Abadan and Aden, and also Ras Tanura and Bahrein. Crude for the new refinery will come from the Persian Gulf.

KUWAIT

Prod. 1,383,165 b/d (1) R.C. 190,000 b/d
Runs 142,562 b/d

Production during 1959 was maintained at slightly below the level of the previous year, off less than 1%. Exports of crude oil were also below the peak 1958 level but refinery throughput increased and exports of refined products rose by approximately one million tons.

One new gathering center with a throughput capacity of 180,000 b/d was commissioned in August in the Burgan field, making a total of 14 centers now in operation in southeast Kuwait. One new center is nearing completion in North Kuwait, which will handle production from the Raudhatain field.

A successful exploration well was completed in August at Minagish, about 21 miles west of the Burgan field, at a depth of nearly 10,000 ft and will produce from the Ratawi limestone. A step-out well was spudded in October to evaluate the structure further. A wildcat exploration well at Dibdibba, 23 miles northwest of the Minagish discovery well, reached a depth of 9400 ft before being abandoned as a dry hole.

Forty-six development wells were completed during the year in the Burgan, Magwa/Ahmadi and Raudhatain fields and in addition, two step-out wells at Sabriya and Bahrah, which had been drilled in previous years, were completed.

Twelve storage tanks at the North Ahmadi tank farm were in commission by the end of the year and construction of the remaining three tanks of the scheduled program was nearing completion. All the tanks are of 262,800 bbl capacity except one of 210,000

bbl. The new 30-in. transit line, 63 miles long, connecting the Raudhatain field to this tank farm was completed and tested and is expected to be in commission in 1960.

The new North Pier terminal was commissioned in mid-June when the first cargo was shipped.

The refinery processed approximately 7 million tons of crude oil during the year. A new Platformer unit went into operation in June. The bitumen plant produced 61 tons per day (capacity 2900 tons a month).

A gas injection plant of 100 million cubic feet capacity for reservoir repressurization is under construction in Burgan and is scheduled for completion in the summer of 1960.

A marine seismic survey of the offshore area of Kuwait within the concession limit was carried out during September.

A contract has been made by BP to supply substantial quantities of liquefied petroleum gas in bulk from Kuwait to the Bridgestone Tyre Company of Tokyo, for industrial and domestic use in Japan. A new plant will be built in Kuwait to produce the propane, butane and possibly ethane. Bottled propane and butane is distributed locally by the Kuwait Natural Gas Company, formed by local merchants.

Reserves: 50 billion bbl.

Consumption: 40,000 b/d, mostly bunkers.

LAOS

Societe d'Etudes et d'Exploitation Minieres de l'Indochine (Petroleum Exploration in Laos) was granted the first exploration concession in Laos by the Laotian Government. It covers areas around Vientiane and Savannakhet.

Uncertainty of the political situation in Laos has clouded the possible results of negotiations in the future.

LEBANON

(1) R. C. 24,000 b/d
Runs 18,000 b/d

The government of Lebanon ratified a new agreement with Iraq Petroleum Company (IPC) under which Lebanon will receive some $144 million in settlement of retroactive royalties dating back to 1952. Most of the amount has reportedly been earmarked for public works development projects.

In November, IPC began work on the construction of a new 30-in. pipeline from the Lebanese-Syrian frontier to Tripoli, 19 miles distant. The new underground pipeline will run parallel to the existing 16 and 12-in. lines. Throughput is expected to increase by 60,000 b/d.

The Naxxar drilling rig of British Petroleum on Malta. The well went to 10,000 feet before it was abandoned. BP has finally relinquished its concession after spending years searching for oil.

Concessions covering several areas (about 1900 sq miles) are held 50-50 by Compagnie Libanaise des Petroles and Gewerkschaft Elwerath. Drilling is expected to start this year.

Consumption: 20,000 b/d.

LIBYA*

A bonanza country is Libya and right now it needs pipelines to get the new-found oil to market. The lines are coming.

Esso, which found the impressive Zelten field, has ordered 100 miles of 30-in. pipe and work on the crude pipeline will begin this year. The fourth well at Zelten has tested 2,500 b/d, the first three having yielded 17,500, 15,000 and 1,500 b/d, respectively.

Two other companies in Libya are planning pipelines to the seaboard; Oasis (Conorada) which has reserves estimated at 1000 million bbl at Bahi-Dahra, 80 miles from the coast, and Caltex which has the Beda field, about 120 miles due south of the Gulf of Sirte.

Oasis has made a further discovery in Libya, at its well B-1-59, about 55 miles south of Esso's prolific Zelten field. The company, (Ohio, Continental, and Amerada), besides the field at Bahi-Dahra and this new find, has a discovery in Western Libya.

The Petroleum Commission has granted oil concessions to MOSEAS (offshore concession) and to CORI (ENI).

CORI will forego depletion, will pay a royalty of 17% (instead of usual 12½%) and the Libyan Government has option to join company. This is similar to other ENI contracts.

Pan American International (Standard Indiana) has been granted the last remaining 3223 sq mile concession in Zone 2, north part of Cyrenaica.

Some 26 rigs are in this new oil boom nation.

The Libyan Government has now approved the arrangement whereby Esso has acquired an undivided half interest from Libyan American (Texas Gulf Producing) and W. R. Grace in three concessions in Cyrenaica and Tripolitania, including two completed oil wells yielding 2000 b/d and a third under test. Esso will be operator.

Construction of an oil refinery at Benghazi is being considered, according to Petroleum Commission of Libya.

Reserves: Too early to estimate.

Consumption: 3500 b/d.

MADAGASCAR

Two drilling rigs are operating for SPM, which has been exploring this island off the African east coast since 1953. Three wells were drilled in 1959, all dry. Geology crews worked 13 crew-months and geophysical 10.4 crew-months.

Consumption: 2600 b/d.

MALAYA — SINGAPORE

In 1960 Malaya will have an encouraging refining construction program. Shell plans two oil refineries—one in Singapore on Pulau Bukom and one in Malaya. Malaya and Singapore are

TURN TO PAGE E-1

*For comprehensive study see Global Notebook in *The Petroleum Engineer* for December 1959, "The Desert Blooms."

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How to SCREEN OUT the 'BAD APPLES'

Here's a check list that may save you trouble and cut down on turnover — It adds up to a barrier for people you shouldn't hire

Ernest W. Fair

SOME OF THE ABLEST personnel men in the oil industry readily admit that one big problem in interviewing people for employment is to spot the undesirables in advance of hiring. And in many companies the man who does the hiring is not a trained personnel man. Screening out the "bad apples" before they get into the barrel can be done but it takes some conscious effort. There is no positive assurance that every one will be caught in time since such individuals are usually most adept at hiding their true personalities but the vast majority can be spotted through exercise of a few choice steps during the interviewing procedure.

From actual experiences of personnel men with the best records in this respect here are a number of suggestions which can be followed.

Dwell on past experiences and don't ever forget them! Too often we make little effort to analyze the type of individuals whom we approved in the past and yet turned out to be "bad apples." Most of us want to forget these experiences.

Keeping them constantly in mind, on the other hand, can be our assurance of being better equipped to spot the next one of that nature who crosses our path. You might keep a list of such individuals in your desk. The list should contain not only the individual's name and characteristics but anything that can be recalled about the interview. This is a hind-sight procedure which can pay dividends for the executive who possesses even the smallest amount of analytical ability.

One bad apple can spoil the whole barrel.

Ask leading questions during the interview – leading questions designed to bring out objectionable traits even if it is necessary to step out of character in order to do so.

Practically every such individual has developed a rigid mask to use at job interviewing time. Usually he is well aware that if the true facts concerning himself are known he will have little chance for the job.

Piercing that mask is relatively easy.

Wants to Spot Undesirables

I read your article in *The Petroleum Engineer* for October entitled, "Don't Hire These People" with interest and am writing to ask whether you have any suggestions as to how one, during an interview, may detect that an applicant is a "bad apple." Do you have an interviewing technique for drawing out a job candidate so that he may reveal his true attitudes? It is often difficult to spot such undesirables in advance of hiring. Some of our most able people readily admit that their records are poor in this phase of their personnel work. I would, therefore, urge you to write a sequel to your article which might carry the title, "How to Screen Out the Bad Apples Before They Get Into the Barrel." In any event, I would be most interested in your comments along these lines.

Robert Capell
Pittsburgh, Pennsylvania

We merely have to recognize that such a guard can exist with every person who comes before us and deliberately set out to break it down.

Ask for personal references as well as job references and check them as closely as possible — and check beyond those actual references. One man uses the names given him by the applicant only to discover other individuals associated with the applicant and the references. It is these people to whom he makes inquiries concerning the applicant for the very obvious reason that those given him are most apt to be favorable toward the applicant.

It is always well to keep in mind when making such a check-up that the men who work with the applicant can give a much truer picture of what he is like than any executive in the company where that individual was last employed.

Which apple has the worm? You can find out by following your check list.

Try to bring out belligerency in an individual during the job interview. Wherever such a person may be suspect it will always pay to so "bait" the job applicant. Few indeed are we humans who can retain our complete composure under such circumstances. When this is aroused we are certain to reveal information that would never have been granted under normal conditions.

When the interviewer deliberately sets out to bring this belligerency to a high pitch he may well learn if such an undesirable trait is in that person's make-up.

Look for intolerance of any sort. People cannot hide it when once given an opening. And almost invariably undesirables are deeply intolerant about something or someone. A remark or so made during the interview will usually set such an individual off on his favorite subject. This chance, given with a degree of cleverness by the interviewer can cause no damage with the individual who does not possess intolerance.

In studies made of such people, i.e., the "bad apples," invariably a prime trait found is intolerance for someone or something. It is a valuable indicator.

Check closely into the individual's social club life. If he has none whatsoever there is always a chance that he cannot get along with people and has retreated into a shell; such action invariably creates an undesirable complex in a person.

This does not mean, of course, that every such individual is an undesirable one from the standpoint of being a good worker. But it is one more of those indicators that should be explored. It should never be considered an absolute and final one, however, only a spur to closer personal investigation.

Watch little mannerisms during the interview. Too often we shrug such things away as being unimportant to the job; if they are an indication of nervousness, stubborness or any such undesirable condition they are very much worth our attention during the job interview.

Chiefly, such negative mannerisms on the part of a job applicant are tip-offs to other and better hidden undesirable features in that person's character. Once again they give us a clue to the need for close investigation of an applicant we otherwise would have passed over as satisfactory.

Watch out for the man who has a record of many job changes. Give him the full treatment no matter how skilled he may be or how badly he is required for an open job. There are occasionally good and legitimate reasons for the existence of such a job record but in the vast majority of cases the reasons are anything but good.

Frequent job changes by an individual definitely spot some one who has proved unsatisfactory in many other firms. It's always an excellent thought to remember that top-notch employees are so valuable no firm is going to willingly dispense with them.

A defeatist attitude is always the tip-off to an undesirable individual. If interview questioning has any depth whatsoever, it is sure to crop up by just a leading question or two. It can almost never be spotted where only written questions are presented job applicants and little personal interviewing is done.

Which brings up a most important point — "bad apples" invariably get by the best planned written questionnaire. Dependence upon them solely is invariably assurance such workers will be slipping through all of the time.

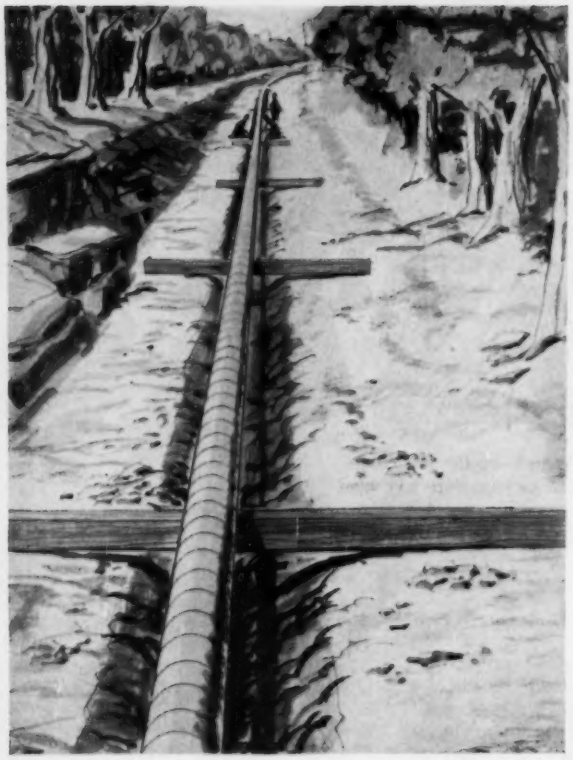
Put suspected individuals on a "trial run" at the job if merely for a single day. This is particularly true if the foreman or superintendent in charge has the least amount of ability to measure such things in a man. He and his fellow workers can often detect things in a job applicant which that individual will skillfully hide from the employment interview given him in anyone's personnel department.

Use a printed "problem" or "what-would-you-do" series of questions with each applicant so designed as to bring out such undesirable traits if they are present in the individual. He will be on guard, of course, but even then — hints of their presence will often be revealed by such a questionnaire.

The difference between this and conventional programs of like nature is that trying to keep out the bad workers is seldom made a part of such lists. When elements designed to secure such information are inserted, it becomes a much better tool for use in picking personnel.

Run a credit bureau check on the individual. The small fee involved will often uncover data on an individual which will reveal an unstable personality.

Encourage the individual to talk and ask questions. The man who evidences more concern over "fringe benefits" with respect to a job can always be suspected of lack of true job interest. The tone of such an individual's questions and comments can also be a tip-off to an "agitator" or "gold-brick." ★



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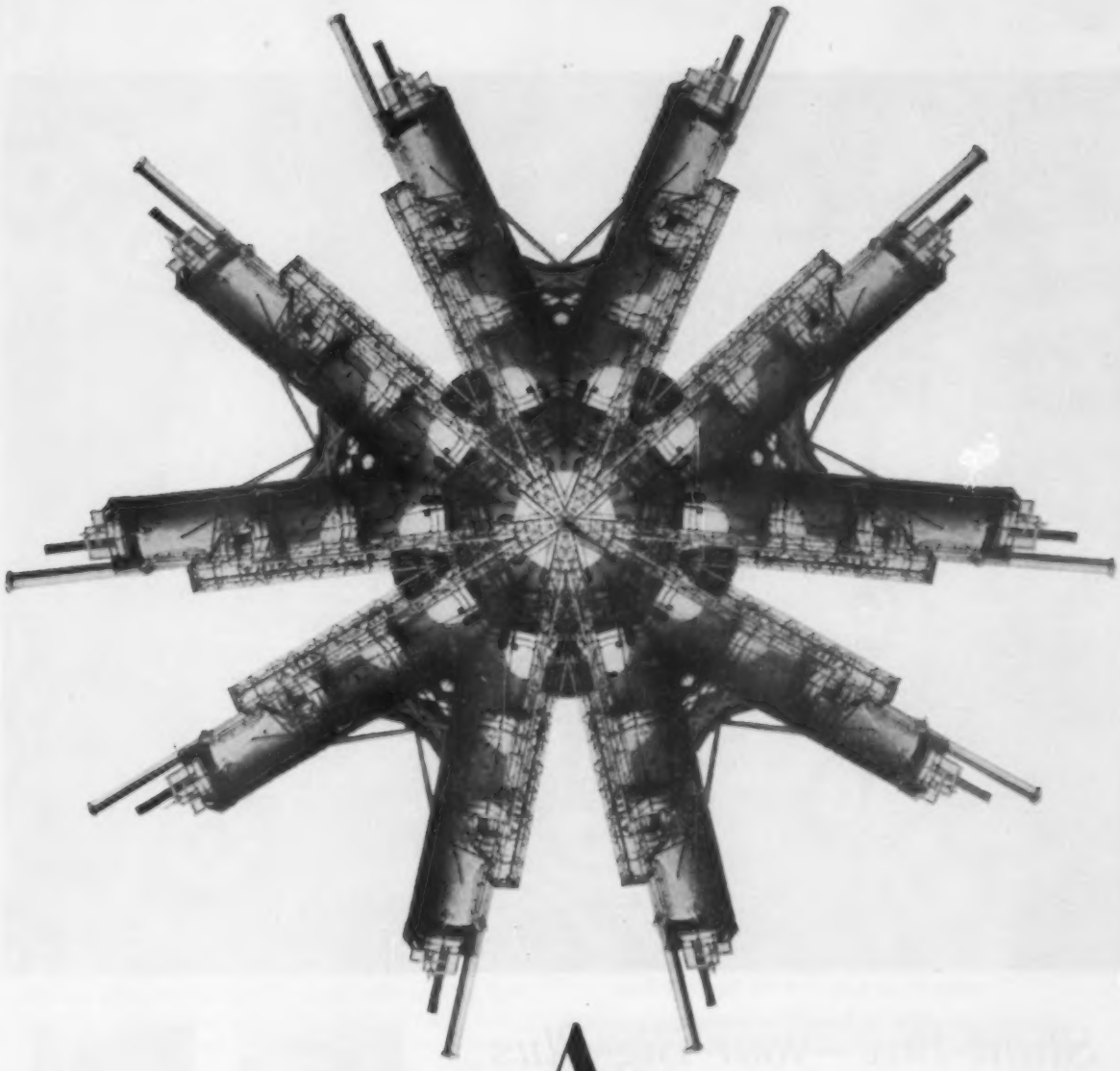

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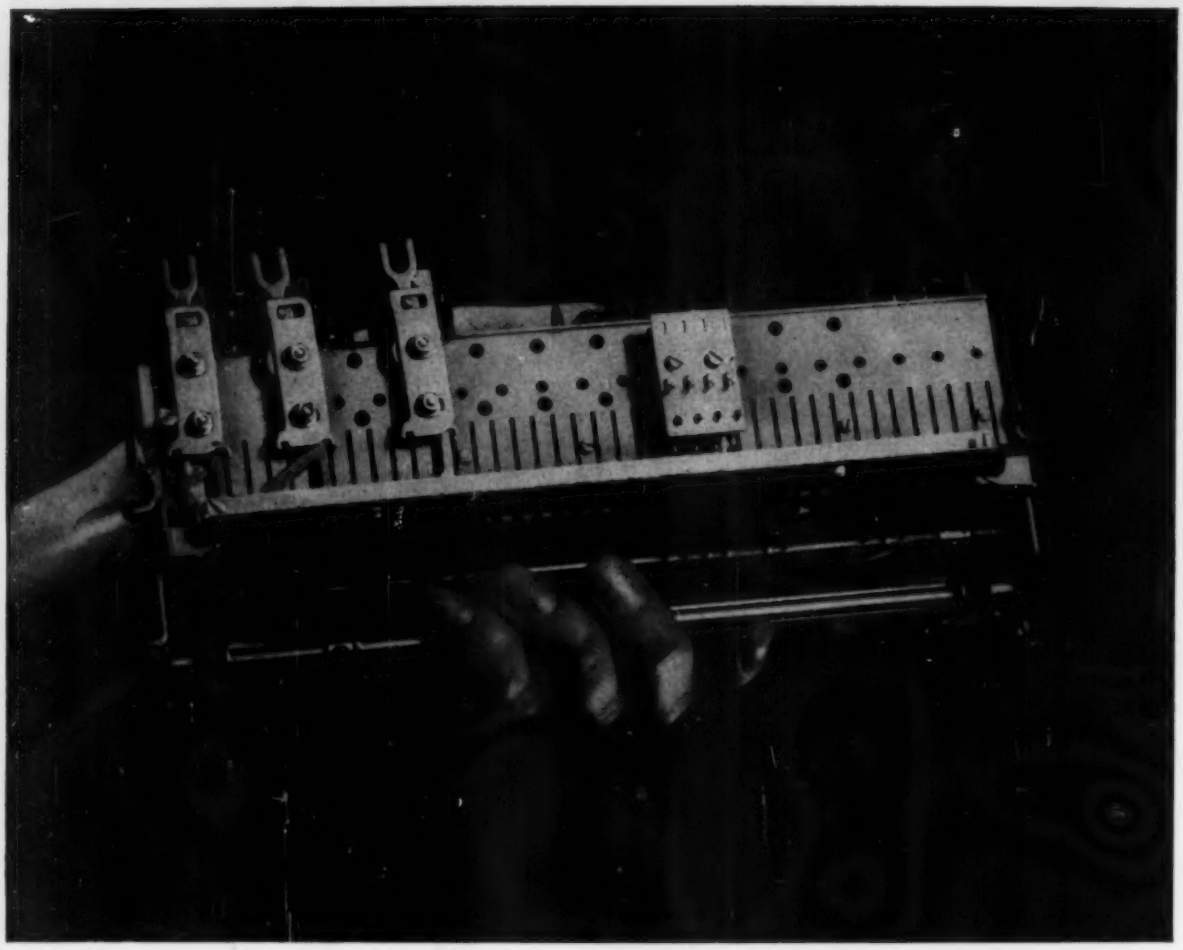

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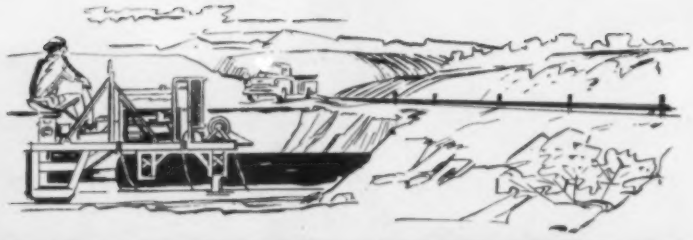

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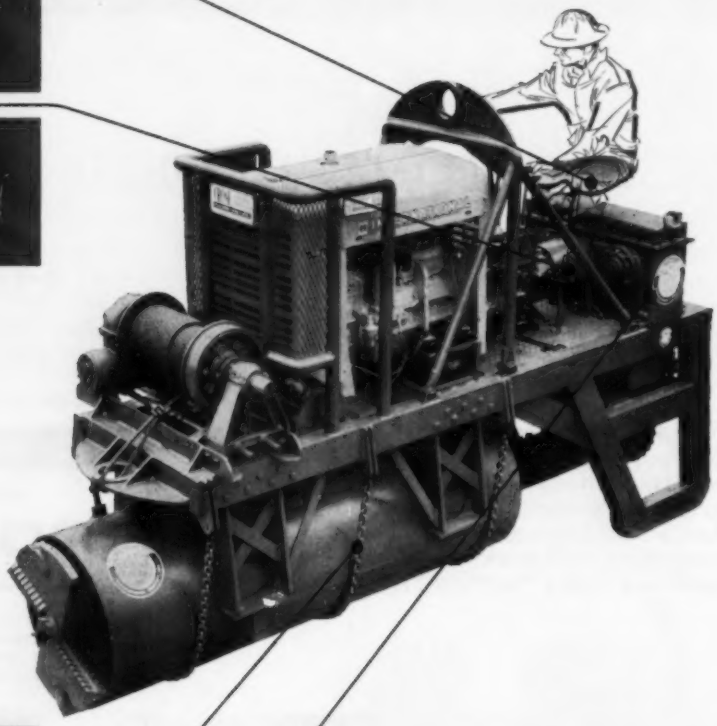

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The magic of pipeline transportation spread across countries in 1959 at what may well be the largest expansion ever made in one year. This scene near Poza Rica, shows units of pipe being launched through swampland (Pemex photo.)

each independent countries within the Commonwealth.

Stanvac expects to build an oil refinery and a chemical fertilizer plant at a cost of $30 million in Malaya.

Maruzen and Koyo Manka Kaisha (both Japanese companies) have a 20,000 b/d refinery scheduled in Singapore.

Consumption: Inland 14,000 b/d; bunkers 34,300 b/d.

MALTA

BP went to 10,000 ft at its last test in Malta and drilling operations have been halted. The company, which had the only concession, spent $2 million on exploration before abandoning its permit.

Consumption: 3420 b/d.

MEXICO

Prod. 289,748 b/d **R. C. 311,200 b/d**
Gas 900,000 mcf/d **Runs 272,800 b/d**

The long-awaited regulations to the Petroleum Law of November 29, 1958, published in the Diario Official of August 25, 1959, gives the Ministry of the National Patrimony all authority and responsibility of supervising the Mexican petroleum industry. The Ministry will reassert state control, through Petroleos Mexicanos, over exploration, exploitation, refining, transportation, and first sale of petroleum and petroleum products.

Regulations also attempt to define the area of petrochemistry reserved for state operation, but products which only the state or its agents may produce are not specifically listed. Decisions as to such products probably will be made administratively as specific investment projects are presented by private investors for government consideration.

Although targets were missed in 1959, Pemex did make gains over 1958. Of 81 exploratory wells, 10 opened fields; of 359 field wells, 298 were completed to produce. There were 22 crews exploring possible production areas in 1959, 5 gravity meter parties and 17 seismic crews plus 19 geology crews. Last report was that 133 rotary rigs were operating in the country.

Production of crude oil and natural gas liquids rose 5% instead of the 10% rise set as a production target. Demand did not justify higher extraction.

This was the first year Pemex had enjoyed the higher prices permitted by government for oil products, which improved its financial position. At the end of 1958 total deficit was $17,201,265, including an operating loss of $9,238,000 in 1958.

Credits extended in 1959 were: $40 million from U. S. banks, $65 million from French banks, and $20 million from U. K. equipment manufacturers.

Before Pemex will have a chance to clear up its obligations, it is being required to pay the government in 1960 at the rate of 12% of gross on a day-by-day basis.

Plans for 1960 call for (1) $48 million investment program in fertilizer plants in Minatitlan, Salamanca, and Chihuahua; (2) $8.8 million for a gas pipeline from Mexico City to Salamanca; (3) $5.5 million for a gas line from Monterrey to Torreon and (4) $5.3 million for a products line from Monterrey to Torreon, and (5) $17 million for a products line from Minatitlan refinery to Mexico City.

Additions to Pemex plants scheduled to be completed in 1960 are: At Poza Rica a 13,500 b/d distillation unit; at Madero a 55,000 b/d distillation unit; at Madero a 23,000 b/d cat cracking unit, and at Minatitlan a 45,000 b/d distillation unit.

Reserves: 2500 million bbl crude oil; 8059 billion cu ft gas.

Consumption: 280,900 b/d.

MONGOLIA

Prod. 2100 b/d **R. C. 2000 b/d**
Runs 1900 b/d

The Mongolian People's Republic is the most under-developed industrially of Russia's satellites. However, a small oil industry has been established, and Soviet plans called for a "substantial growth" in both production and refining during the 1957-1960 period.

Oil production in 1956, according to official Russian figures, was only 50,000 metric tons. Even so, in 1956 and 1957 some of the crude was sent to the USSR for lack of refining capacity in Mongolia. The expanded and modernized Zun-Bayan refinery now processes much of Mongolia's crude, and there were no exports to Russia in 1958.

Oil has been found in lower Cretaceous sands and sandstones near Sain Shanda in southeastern Mongolia near the Chinese border.

At present, Russia supplies a good part of Mongolia's petroleum products requirements.

Consumption: 3300 b/d.

MOROCCO

Prod. 1956 b/d **R. C. 3350 b/d**
Gas 753 mcf/d **Runs 3270 b/d**

At the end of 1959 one geological

crew and one drilling rig were operating. Earlier in 1959, however, 4 rigs were drilling and 22 wells went down during the year, 9 producing and 13 dry. A total of 97 wells now produces oil and gas.

Societe Cherifienne des Petroles has the only production, which is slightly ahead of last year. Natural gas output increased sharply from last year.

The Moroccan Government has granted Ambassador Oil Company of Texas an exploration license covering Hamada du Dra, Kem-Kem and Hamada du Guir, southeast of the Atlas Mountains, in areas claimed by Morocco in the Sahara. Somip (ENI) is moving in a drilling rig to explore its 11,580-sq-mile Tarfaya concession. If production is found the government will own half.

A 5-in. gas line is being built from Haricha field 8 miles to the Sidi-Kacem refinery, only one in Morocco.

The government plans an oil refinery at Mohammedia and Samir will build a 25,000 b/d refinery at Fedala.

Reserves: 10 million bbl oil; 20 billion cu ft gas.

Consumption: 20,000 b/d; 753 mcf/d gas.

MOZAMBIQUE

Exploration was pursued by the Gulf-Standard Indiana combine with one geological crew and 4 geophysical parties. No wells were drilled.

SONAREP, a subsidiary of Sociedade Nacional de Petroleos (SONAP), a Portuguese company, has awarded Procon (Great Britain) a contract to build Mozambique's first refinery.

Complete fuel oil, kerosine and gasoline production facilities will be built at Lourenco Marques, capital and major seaport of the East African country. Refining units will include a 12,000 b/sd crude unit, a 2500 b/sd Platforming unit, 2000 b/sd diesel fuel Unifining unit, a 1500-bbl Merox unit and supporting facilities. Platforming, Unifining and Merox processes are licensed by Universal Oil Products Company. Completion of the refinery is expected in early 1961.

Design of the refinery is keyed to Mozambique's traditional role as a major refueling station and re-exporter of heavy fuel oils. Crude will be supplied from Middle East fields.

Consumption: 3000 b/d.

THE NETHERLANDS

Prod. 33,618 b/d (2) R. C. 349,000 b/d
Runs: 330,000 b/d

Production in the Netherlands has increased steadily (except in 1957) since the Germans, then occupying the country, found oil at Schoonebeek in 1943. Four rigs are kept in operation by N. V. Nederlandse Aardolie Mij (Shell-Jersey) and the search moves ahead each year. Now efforts are being made to select an offshore drilling site. A $1,400,000 under water drilling platform has been ordered which will be used to drill off the South Holland coast in 1961.

Two refineries are: Caltex, 49,000 b/d, and N. V. de Bataafsche Petroleum Mij, 300,000 b/d. A third one, Esso Nederland N. V., will complete its 90,000 b/d refinery in 1960.

Caltex has opened the new Caltex Central Laboratories at Pernis and is expanding its refinery.

Reports are that refineries are planned by Pure Oil and Gulf Oil.

Seven million cubic feet a day of natural gas from oil wells is to be used by MEKOG at Ijmuiden in a new plant for making nitrogenous fertilizers. It will be completed in late 1960. This will be the first application here of natural gas in the chemical industry.

A carbon black plant of 15,000 tons a year capacity will be built near Rotterdam, by Continental Carbon, owned by U. S. companies, Continental, Shamrock, and Witco Chemical. The $2½ million plant is due for completion early next year.

Petrochemicals are fast expanding. Royal Dutch/Shell will soon complete its synthetic rubber products plant near its Pernis refinery. Last year it installed a furfural extraction plant at Pernis. It plans to increase still further the capacity of its synthetic glycerine plant (only petrochemical facility of this kind outside the USA) to at least 15,000 tons a year.

A styrene-butadiene latex plant will be constructed in Rotterdam by Dow Chemical's Dutch subsidiary at the site of its present terminal and warehousing facilities in Third Petroleum Harbor at Rotterdam. Investment in the new plant will total more than $2 million. Completion of the plant is scheduled for early spring of 1961, and its initial annual capacity is expected to be large enough to cover the styrene-butadiene latex requirements of Western Europe.

Work has been completed on the Netherland's section of the 180-mile, 24-in. crude oil line from Rotterdam to the Ruhr and the Rhineland industrial areas and is expected to be opened this year.

Reserves: 200 million bbl oil.

Consumption: Inland 144,000 b/d, up 13% over last year.

NETHERLANDS ANTILLES

(2) R. C. 650,000 b/d
Runs 670,900 b/d

Aruba. Lago Oil and Transport Company (Esso) had a 412,000 b/d average throughput at its 440,000 b/d capacity plant here.

A modern bunkering terminal costing over $267,000 will be built at Oranjestad to supply fuel to tourist ships calling at Aruba by Lago to cooperate with government efforts to attract tourists.

Curacao. Royal Dutch/Shell's 210,000 plant has average runs of 258,900 b/d.

Consumption is 13,700 b/d.

NEUTRAL ZONE

(KUWAIT-SAUDI ARABIA)

Prod. 105,140 b/d (1) R. C. 50,000 b/d
Runs: 25,700 b/d

Arabian Oil Company (60 Japanese firms) discovered oil with its first well on its offshore concession. The well, in 104 ft of water, 28 miles from shore in the Persian Gulf tests about 6000 b/d from 4900 ft. It was drilled by International Drilling Company of the Netherlands, (partners of Reading and Bates, Tulsa, Oklahoma).

Capital of Arabian Oil has been raised to $28 million and a second drilling barge will be employed.

Production in the Neutral Zone rose 31% in 1959. Concessions of land areas are held by American Independent Oil Company (10 firms) and Getty Oil Company (50-50 with AIO).

Four drilling rigs are operating on shore and 145 wells are now producing.

The Getty Oil refinery at Mina Sand operated for its first full year.

Consumption: 2500 b/d.

NEW CALEDONIA

Societe de Recherches et d'Exploitation de Petrole en Nouvelle-Caledonia, French company, has not found results of exploration very promising and work has been suspended on this Pacific island. It is planned to make a new study of the information obtained, before deciding on future activities.

NEW GUINEA

(NETHERLANDS)

Prod. 4729 b/d

A typographical error last year gave 567 b/d production in Western New Guinea when it should have been 5067 b/d. Output of the 3 small fields declined still more last year. Of the 4

wells drilled (one drilling rig operating) all were dry.

One geological and 4 geophysical crews worked during 1959 but reports are that the 100,000 sq mile concession will be relinquished early in 1960 by the New Guinea Petroleum Company (Stanvac 40%, Royal Dutch/Shell 40%, Caltex 20%).

Reserves: Small.

Consumption: 225 b/d.

NEW ZEALAND

Prod. 15 b/d **R. C. 60 b/d**
Runs 14 b/d

Shell, BP, and Todd Oil Services drilled one well with gas-condensate shows at Kapuni, Taranaki County, North Island, and now another site is located on the East Coast. Two geological and two seismic crews are working in Taranaki and a second rig of heavier capacity will be added.

BP's southernmost permanent storage depot was recently commissioned by BP (New Zealand) Ltd. Situated at Bluff, the port for the city of Invercargill, at the southern tip of New Zealand's South Island, the depot, which has storage facilities for motor spirit and gas oil, includes tankage, loading lines for road tankers and an office building.

An oil refinery to supply New Zealand's needs is planned by overseas oil companies, among which are the Shell group, Caltex, Stanvac, Europa, and Atlantic Union, with 40% New Zealand capital. Estimated cost is $56 million. Initial capacity will be 40,000 b/d and completion date is set for 1964.

Consumption: 32,000 b/d oil products, a drop from the 37,000 b/d in 1958.

NICARAGUA

Occidental has relinquished its concession in this Central American country.

Applications have been made by George Greene of Texas to explore for oil on 500,000 acres and the Cia Central Nicaraguense de Petroleo y Gas, S. A., for 1,000,000 acres.

Esso presented a proposal to construct an $8-$10 million refinery at Corinto, the most important port on the West Coast of the republic.

Consumption: 3000 b/d.

NIGERIA

Prod. 15,000 b/d

Legislation was passed in 1959 committing the Federal Government to the 50-50 oil profit-sharing principle. Also the Nigerian Government announced procedures to be used by companies wishing to apply for oil exploration or oil prospecting licenses in the country. Specific details such as fees, areas to be covered, duration of license, and obligations of licenses are given. Shell-BP will relinquish a number of areas in 1960.

March 1, 1960, was the first date on which applications for the Continental Shelf area would be accepted and April 1, 1960, was the first date on which applications for new land areas would be accepted. A copy of the full text of the announcement is available on request to the Near Eastern and African Division, Bureau of Foreign Commerce, U. S. Department of Commerce, Washington 25, D. C.

All production so far is that of Shell-BP (50-50), which found oil in 1956. There are 27 producing wells, 16 of which are in the Oloibiri field. Afam and Bomu are the other fields.

Oil in appreciable quantities has also been found for the first time in the western region delta province of Nigeria, at Ughelli, by Shell-BP. The well was the sixth drilled in this region where exploration commenced six years ago.

Ughelli is 60 to 70 miles from all other sources of oil so far discovered in Nigeria and work is continuing. Shell-BP has 8 seismic parties — a total of 2000 men working on exploration alone and other services, including drilling, employees 3000 men.

Shell-BP is also drilling a deep test well at Naxxar, near Valetta, Malta. It is planned to reach a depth of 15,000 ft if necessary. Although drilling has been proceeding for almost one year, progress has been slow owing to the extremely difficult structure which the bits have to penetrate.

During 1959 Shell-BP drilled 37 exploratory wells and nine are oil wells. In the last 22 years Shell-BP has spent about $170 million searching for petroleum in this country.

In 1959 a 14-mile 12-in. crude line was constructed from the Bomu field to Afam where it connects with the line to Port Harcourt.

The pipeline will be extended this year to Bonny Island where an ocean terminal will be built.

After being granted its exploration license in the western region, Mobil Exploration Nigeria drilled its first test at Afowo, in the extreme southwest. It was dry. Mobil has one seismic crew in Nigeria.

Reserves: About 130,000,000 bbl in three fields.

Consumption: 10,000 b/d, including bunkers.

NORWAY

R. C. 2200 b/d
Runs 2000 b/d

Esso, which has a small plant at Tonsberg, the only one in the country, is building a 40,000 b/d plant at Slagenstangen.

Shell is to study the oil prospects of Spitzbergen which, some 350 miles north of Norway, has a temperature above freezing point for only three months of the year.

Consumption: 61,300 b/d, the same as in 1958. The Norwegian Government sets prices for most oil products.

OMAN—MUSCAT—DHOFAR

Over the Sultanate of Muscat and Oman, the IPC subsidiary, Petroleum Development (Oman) has a concession that expires in the year 2012. The company is doing some survey work in the southeast coastal region. It abandoned its second well at 12,661 ft and began a third test.

In Dhofar, on the south coast of the Arabian peninsula, Cities Service concentrated the major portion of the years' exploration program on seismic work and shallow stratigraphic drilling. Two deep tests, completed early in 1959, failed to find commercial oil. At year end, a deep test was drilling below 5000 ft. Several shallow and two deep tests are planned for 1960 on some of the best undrilled structures.

Richfield has a 50% working interest in this project.

PAKISTAN

Prod. 5594 b/d **(1) R. C. 5600 b/d**
Gas 62,794 mcf/d **Runs 5594 b/d**

For the first time since the new state of Pakistan was established, oil has been found. The well was drilled by Pakistan Petroleum (Burmah Oil 70%) in partnership with Pakistan Oilfields (Attock Oil). (In both companies there is Pakistani capital participation.) Karsal No. 1 drilled to 12,751 ft, found indications of oil in 1956 and has since produced small quantities intermittently, Karsal No. 2 found no oil, and now Karsal No. 3 has found oil in Eocene limestone at 11,664 ft and will shortly be put on production at a rate of 800 to 1000 b/d. This is the first discovery of oil in Pakistan since 1947, when it was part of India.

Situated northwest of the Balkassar field and about 65 miles southwest of Rawalpindi, the Karsal oilfield lies in the Potwar Plateau of West Pakistan in an area where the only known oilfields of Pakistan are.

Immediate steps are being taken to pipe the crude oil from the new well to the oil refinery at Rawalpindi.

New gas reserves were added too. Standard Vacuum discovered large gas reserves in West Pakistan 26 miles northeast of Karachi. This is Stanvac's first success in Pakistan after drilling 7 wells. The new well will be drilled

deeper to get fuller estimates of the extent of the strike. The project is being financed jointly by the government and Stanvac. The company has 3 exploration parties at work.

Pakistan Petroleum and Tidewater's joint well at Drigh Road, Karachi, has been abandoned at 12,948 ft; no oil was found but gas shows were met in limestone between 8000-9000 ft. Pakistan Petroleum and Pakistan Oilfields have spudded-in Domanda 1 on the edge of the Sulaiman Mountains, 120 miles northwest of Multan. Pakistan Shell moved a rig from the Multan district, where the company drilled a dry hole at Karampur, to East Pakistan, where a location was made at Rashidpur in the Sylhet district.

Ten drilling rigs operated in Pakistan in 1959, completing 19 wells in all, 12 producers.

West Pakistan is rich in natural gas. The Sui field alone has 5 trillion cu ft of gas reserves and output in 1959 was 17 billion cu ft. Extensions are being made to the purification plant at Sui so that 120 million cu ft a day can be supplied to the surrounding areas and by pipeline to Multan. There are plans to extend the line still further north to Labore, Rawalpindi and Peshawar.

Following negotiations of Continental Carbon (Conoco, et al), the government of Pakistan and Burma Oil, a plan has been approved for a $7 million project in Sui to manufacture 36 million lb of carbon black a year, consuming some 70 million cf/d of gas.

Sui Carbon Company, Ltd., will be incorporated in Pakistan to own and operate the plant. BOC will be responsible for the management although technical advice will be available from Continental Carbon.

The government also plans a petrochemical plant at Sui to use gas as raw material.

Constock International Methane is discussing with the government and Pakistan Petroleum a plan to ship gas from the Sui field to markets in Japan, Australia and South Africa.

Agreement on construction of a 30,000 b/d oil refinery at Korangi, Karachi, Pakistan, was reached November 28, 1959 between a consortium of petroleum companies (Stanvac, Caltex, Burmah Oil, and Burmah Shell) and the Pakistani Government.

Cost of the 32,000 b/d refinery is estimated at $34,650,000. Construction will begin mid-1960 and it is scheduled for completion the last of 1962.

Crude for production of gasoline, furnace oil, kerosine, and light diesel oil will be purchased from abroad on a competitive price basis. No aviation gasoline, high speed diesel oil, greases, or lubricants will be processed. Foreign exchange savings for Pakistan are estimated at $7 million annually. Pakistan now has one refinery located at Rawalpindi which operates on locally produced crude.

Reserves: 16 million bbl; 8080 billion cu ft.

Consumption: Domestic 41,900 b/d, bunkers 2100 b/d.

PANAMA

(INC. CANAL ZONE)

In Panama, Eastern States Petroleum Chemical Corporation has been granted a concession of about 1,350,000 acres.

Champlin abandoned its test on the Caribbean Coast and apparently no other drilling has been done.

In 1957 two companies contracted with the government to build refineries but neither has been started. Panama Refining and Petrochemical Company, Los Angeles, turned over its refinery project to Ultramar, a British company.

Consumption: 18,500 b/d.

PAPUA

Oil exploration in Papua has not yet succeeded in discovering a commercial accumulation of oil, although appreciable gas flows have now been encountered in three structures (Kuru, Barikewa and Bwata).

Late 1958 oil was encountered in Puri No. 1 in a Miocene subthrust limestone block but went to water after flowing for a few days. To appraise the significance of this discovery, two deviated holes from Puri No. 1 were drilled in 1959, but no gas or oil formed so the site was abandoned by Australasian Petroleum and Island Exploration.

One hole was spudded in (August 1959) at Bwata, 15 miles northwest of Puri. The hole was completed in January 1960 at 7302 ft. Gas was encountered in the top of the Miocene limestone sequence and water lower in the sequence. The well flowed gas at rates approaching 30 million cf/d.

One geological party and one seismic party operated during 1959 south of Puri. Now the companies have turned their attention further to the West and are preparing a drilling site at Iehi, 12 miles northwest of Barikewa, the objective being Cretaceous sands. A geological party is also operating in the area.

Supplies for the operation are being taken up the Kikori River to Barikewa, which is being established as the river base. From Barikewa all equipment, including the rig, will be flown into the drilling site by helicopter, which will also be used to maintain communication when drilling starts. The preparatory work is expected to take several months before drilling can begin, probably in the middle of the year.

Two of the partners in Australasian Petroleum, BP Exploration Company and Oil Search Ltd., are each subscribing $2,240,000 to finance the drilling of the Iehi No. 1 well. The third partner, Stanvac, is not participating in the Iehi venture.

Consumption: 800 b/d.

PARAGUAY

Pure Oil Company has suspended exploratory operations in Paraguay following failure to discover oil after drilling four test holes. However, the company and its associates are retaining an interest in 3 million acres of the original 14-million acre concession that they obtained late in 1957. There are no immediate plans for further drilling.

Partners in the venture include Gulf Oil, Sinclair, Tidewater and Williams Brothers.

The fourth well, the Mendoza No. 1, was abandoned after drilling went below 10,000 ft and no oil was found. Natural gas was discovered at 1927 ft but production was considered uneconomic because of the well's remote location.

Acreage being retained for possible future exploration is situated in the northwest Chaco territory near the Bolivian border.

The 10-million acre concession granted to the Brazilian firm, Petroleo Guarani SA, a subsidiary of Fiduciaria Fluminense, Rio de Janeiro, in 1958 has been extended for a period of 16½ months from the end of last October. The company is at present carrying out an aerial survey of part of the area.

Consumption: 1600 b/d.

PERU

Prod. 48,584 b/d (3) R. C. 46,800 b/d
Gas 103,459 mcf/d Runs 42,495 b/d

Principal developments in Eastern Peru last year, aside from the continuation of various geophysical and geological surveys by the large companies, were:

Texas Petroleum suspended all activities in June following three years of geological and geophysical work and four dry wells, three in the Maranon River valley and one near Yurimaguas. Texas is retaining, however 2,000,000 acres of its concession areas. At the end of January 1960 the Texas drilling equipment was moved up the Putumayo River to undertake a drilling venture in southern Colombia.

In December 1959 Union Oil of California, which held a 40% interest in Petrolera S.A., closed its Lima office.

Petrolera Sullana, in which A. & F. Wiese interests of Lima held a 60% interest, gave up all its concessions in the Sechura Desert and in Eastern Peru, retaining only 46,000 acres on the continental shelf. This was leased to Peruvian Pacific under an operating agreement. Petrolera Sullana drilled 7 dry wells on its coastal concessions and carried out geophysical exploration in Eastern Peru.

In the new Maquia field brought in last year by Cia. Peruana de Petroleo "El Oriente" S.A. (West German companies, Gewerkschaft Elwerath, Deutsche Erdoel A. G. and Wintershall A. G.) now has 10 producing wells. Total production of the field through 1959 up to February 29, 1960, has been 80,-305 bbl. Tests are now being run to determine capacity of the field with a view to establishing transport requirements and market possibilities. Located on the Ucayali River present markets are limited to the Peruvian Government refinery at Iquitos (1500 b/d) and I. B. Sabba refinery at Manaus (5000 b/d). Last year "El Oriente" built a 4-mile pipeline to the Ucayali River and storage tanks at the river port. It also acquired two 8000-bbl barges.

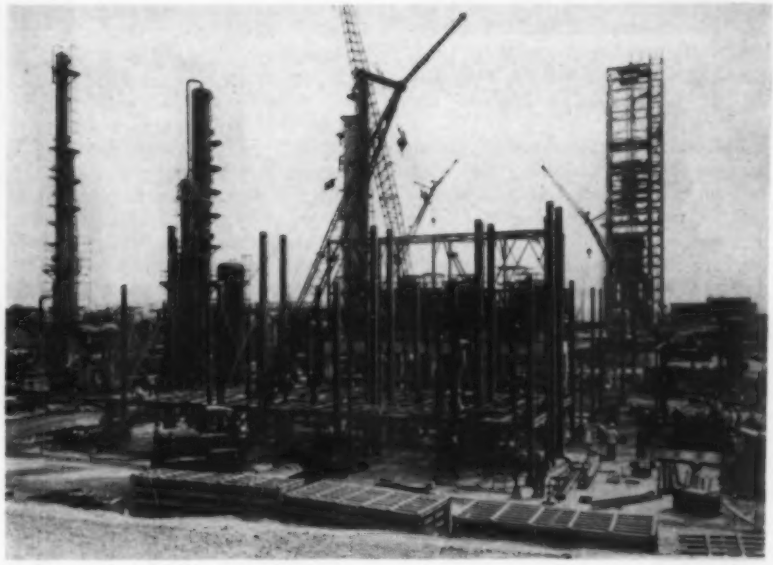
Cia de Petroleo Ganso Azul, Ltda., (Texas Gulf Producing 80%) now has 14 producing wells at its Agua Caliente field on the Pachitea River above the junction of this river with the Ucayali. Production in 1959 was 804,175 bbl. The company has four 12,000-bbl and four 8000-bbl barges and the tugboat "Amazon Queen" especially designed for the downriver service to Manaus and Iquitos from Pucallpa. The Agua Caliente field is linked to Pucallpa by a 47-mile pipeline. Storage tanks and a 400 b/d topping plant — supplying the local upriver market — are located at Pucallpa.

Neither "El Oriente" nor "Ganso Azul" are planning further drilling for the present, their immediate problem being that of marketing.

Only drilling project announced for Eastern Peru during the current year is that of the Cerro de Pasco Petroleum, subsidiary of Cerro de Pasco Corporation, which plans to sink an air-supplied wildcat on its concession.

Peruvian Pacific (Cities Service and Richfield) early in 1959 chartered from Richfield drilling barge "Rincon" to explore the petroleum possibilities of the continental shelf off the coast of northern Peru. It plans to extend its operations this year.

On March 13 this year, Belco Petroleum of Peru (New York) announced that it had definitely brought in an offshore producer on its "Litoral" concession opposite Talara, in northern Peru. The well was sunk to 2000 ft by directional drilling from the mainland.



Construction progress photo at Stanvac's Bataan refinery taken in late January 1960, shows framework of cat cracker flanked on left by naphtha catalytic hydrodesulfurizer, crude unit atmospheric tower and H_2S stripper-splitter tower. Company aims to put 24,000 b/d plant onstream late this year.

Production of International Petroleum's La Brea y Parinas oilfields in 1959 was 8,223,956 bbl. Production of the Lobitos oilfields, operated by IPC and owned 50-50 by IPC and Lobitos Oilfields, was 7,535,040 bbl. Owing to the unrealistic prices imposed by the government on sales of petroleum products in the domestic market, IPC and Lobitos had been forced to abandon drilling operations at the beginning of 1959. However, the government on July 25, 1959, decreed an increase in domestic prices so drilling was renewed from August onward with 6 rigs reported operating.

Production of Empresa Petrolera Fiscal (government) in 1959 was 928,-516 bbl. This production is almost entirely from Los Organos field, in the Lobitos concession, transferred to EPF some years ago.

Mobil International completed a 55,000 bbl per year lubricant-blending plant at El Callao.

Reserves: 375 million bbl, 711,398 million cu ft of gas.

Consumption: 41,600 b/d.

PHILIPPINES

(1) R. C. 24,000 b/d
Runs 23,225 b/d

Discovery of a possible commercial field on the island of Cebu last year has encouraged exploration of the Philippines.* Some 20 companies have concessions covering more than 20 million acres on the Archipelago. There were some 93 geological and 7 geophysical parties working in 1959.

Four rigs in operation drilled 13 wells and 16 stratigraphic tests. Two deep wells, Reina Regente wells 1-A and 1-A-X, both found oil and zones are being tested.

The Caltex refinery at Batangas is the only one in operation. Standard-Vacuum will have its 24,000 b/d refinery at Limay, Bataan, completed in 1961. Shell (75%) and local interest (25%) will build a 25,500 b/d refinery at Tobangao on Luzon.

Upon completion of financial arrangements, Gulf will have approximately 20% interest in Filoil, a Philippines group which plans to construct a 10,000 b/d refinery.

Consumption: 51,500 b/d in 1959 including bunkers.

POLAND

Prod. 3,400 b/d **R. C. 18,000 b/d**
Gas 38,700 mcf/d **Runs 16,500 b/d**

Russia, in a long-term trade agreement signed in Warsaw on March 10, 1960, guaranteed to "deliver oil sufficient to meet all of Poland's domestic needs from 1961 through 1965." Under the pact, the USSR will send Poland 8.5 million metric tons of crude and 7.7 million metric tons of oil products in the 1961-1965 period. Some of the crude will be delivered via the proposed new 2500-mile oil pipeline, one branch of which will pass north of Warsaw en route to East Germany. It will feed a new refining center at Plock, northwest of Warsaw.

This installation, on which construction is slated to start in 1960, is to have

* "First Commercial Oil Discovery for the Philippine Islands," by Joseph A. Kornfeld. *The Petroleum Engineer*, April 1960, Page B-101.

a capacity of about 40,000 b/d of crude oil. It is expected to fill 70% of Poland's products requirements by 1965. The Plock refinery will be built with the aid of Russian technicians and equipment.

Poland has been increasingly dependent on Russian crude. In 1958, when its own crude production was around 180,000 metric tons, it imported 553,900 metric tons of Russian crude. Polish imports of Russian oil products during 1958 reached a new peak.

In contrast to its stagnant crude production, Poland's natural gas output appears to be increasing, and government officials are highly optimistic about the future. They predicted that natural gas output would increase more than 23% in 1959. Goal for 1965 has been set at 1 billion cubic meters compared to actual output of 350 million cu meters in 1957.

Reserves: 25 million bbl oil; 190,000 million cu ft.

Consumption: 40,000 b/d oil products, 11% higher than in 1958.

PORTUGAL

(1) R. C. 30,000 b/d
Runs 22,500 b/d

Mobil Exploration Portugal has drilled 8 wells in its exploration program, all dry. The government and Axel Johnson (Sweden) are associated with Mobil.

The refinery (where expansion program is presumably completed) belongs to SACOR (government 33⅓%, CFP 8¾%, and private interests 58%). Recently the company purchased 50,000 tons of Soviet oil.

Consumption: 22,450 b/d.

PORTUGUESE GUINE

Esso Exploration Guine, Inc., the only company operating in Portuguese Guine, has an exploration concession covering approximately 11,000,000 acres. Exploration surveys were initiated in mid-1958. A geological crew and two seismic crews are working.

Consumption: 120 b/d.

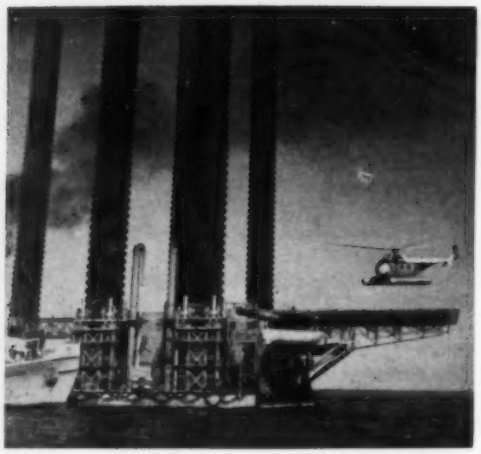
PUERTO RICO

(2) R. C. 75,000 b/d
Runs 66,000 b/d

Kewanee Interamerican Oil Company, a group headed by David L. Gordon of Houston, drilled the first well in this country — which was dry. The 200,000-acre concession held by the firm is in the south central section of the island.

Commonwealth Oil Refining Company is partly shut down to expand the plant at Guayanilla Bay, near Ponce. It will have a capacity of 75,000 b/d when completed. Caribbean Refining's plant at San Juan has an 18,000 b/d capacity.

Consumption: 38,900 b/d, inland and bunkers.



A helicopter approaches the 5930-ton mobile drilling platform, Seashell, as it is being towed to location 50 miles from shore in Doha Bay, Qatar (Shell photo.)

QATAR

Prod. 170,403 b/d **R. C. 600 b/d**
Runs 600 b/d

Production of Qatar Petroleum (IPC) slipped back some from last year when it rose to a peak of 176,000 b/d. This company has one drilling rig in operation and 50 producing wells, none added in 1959.

Shell has the offshore concession. In December the company tugged in a $5 million mobile oil-drilling platform, the *Seashell*, to replace one that was wrecked.

Before the storm wrecked the first platform, the rig had drilled two exploratory wells in Shell's marine concession. Results were disappointing but Shell — which by that time had spent $21,000,000 on underwater exploration in the area — decided to try again at another location also about 50 miles off the coast.

The target depth is around 7,000 ft, although the pontoon hull carries drilling machinery with 17,000-ft capacity.

Reserves: 2500 million bbl.

Consumption: 500 b/d.

ROMANIA

Prod. 230,000 b/d **R. C. 240,000 b/d**
Gas 656,000 mcf/d **Runs 230,000 b/d**

Romania continued last year to lag behind its crude production goals. Official data released by the Council of Ministers' Central Statistical Administration showed a gain of only 1%, with specific totals omitted. However, 1959 output apparently remained in the 225,000-230,000 b/d range.

On the basis of official Romanian reports placing 1958 crude production at 11,336,000 metric tons, last year's 1% greater output would be around 11,450,000 tons. (Some Russian sources have stated that Romania produced only 11.2 million metric tons of crude in 1958.) Even if the highest estimates are used, it now appears that Romania's Second Five-Year Plan target calling for 13.5 million metric tons of crude in 1960 is out of reach.

Romania claims that its primary distillation capacity reached "about 12 million metric tons" in 1957 and that its refineries can now handle all domestic crude production.

At the new Onesti refinery two catalytic cracking installations have been constructed.

While crude output is increasing more slowly than domestic oil consumption, Romania is still a substantial petroleum exporter. In 1958 (last year for which complete figures are available) Romania delivered 2,824,300 metric tons of products (about 60% of its total products exports) to Russia. This figure, however, was down substantially from the 3,436,800 tons of products exported to Russia in 1956.

In contrast to crude output, Romanian natural gas production rose 14% in 1959. Since 1958 production was 5075 million cu m, this would indicate 1959 output of 5785 million cu m. In addition, Romania produces about 1000 million cu m of casinghead gas annually.

Consumption: 125,000 b/d.

SAUDI ARABIA

Prod. 1,095,399 b/d **(1) R. C. 189,000 b/d**
Runs 174,273 b/d

A sixth producing field has been added to Aramco's roster. Khursaniyah, 80 miles northwest of Dhahran, was ready to begin production shortly after the close of 1959. Discovered in 1956, the field includes five oil wells.

Producing facilities at the Khursan-

iyah field include a gas-oil separator plant, completed in March 1960, and a pump station previously built. Cost of the new production facilities in the area is budgeted at $3,300,000.

The oil will be transported by way of Safaniya-Ras Tanura pipeline to Ras Tanura for stabilizing and offshore shipment or processing in the refinery. One possible production schedule calls for batching 45,000 b/d from Khursaniyah and 75,000 from Safaniya through this pipeline.

Already Aramco's production is at record peaks, rising 7.9% in 1959.

Arabian American Oil Company (Standard of California, Texaco and Jersey, each 30%; Socony Mobil, 10%) is the only concession holder. Its concession includes some 340,000 sq miles, including offshore areas.

In conformity with a previous agreement between the Saudi Arabian Government and Aramco, two government nominees have now been elected to Aramco's board of directors. They are Sayyid Abdullah Tariki, Director General of Petroleum and Mineral Affairs, and Shaikh Hafiz Wahba, formerly Ambassador in London.

The government is said not to favor other concessions unless the government has a share in refining and marketing also.

Last year Aramco drilled 22 wells, including 12 producers. Of the others 5 were abandoned, 2 are gas injection wells and 3 observation. As of the end of 1959, Aramco had 203 producing wells. Two seismic crews and two structure drill crews are engaged in exploratory work, concentrating on the Rub' al-Khali.

Last year Aramco began advertising "Natural Gas for Sale" offering "low price and favorable contract terms" to induce industries to move into Saudi Arabia within reach of its gas supplies.

The company is constructing a $6,500,000 plant at Ras Tanura terminal to make liquefied petroleum gas available for export. It will be liquefied by refrigeration instead of by compression. The plant — the first in the world to make refrigerated LPG available for tanker shipment — will have a capacity of 4000 b/d and is scheduled for completion in 1960. It will cool the gas to 25 deg below zero for shipment as a liquid in special refrigerated tankers. Facilities will include two 80,000-bbl steel tanks to store the refrigerated LPG at atmospheric pressure and a 22-in. pipeline.

Aramco uses approximately 400,000 mcf/d of gas in repressuring operations to increase recoverable reserves in the Abqaiq and 'Ain Dar reservoirs.* A program to expand this gas injection with a miscible phase project at the 'Ain Dar area of the Ghawar field is now in progress. The operation will require an 18,000 brake-hp plant, which will be constructed at Abqaiq, to compress 55 mcf/d of LPG for injection into the 'Ain Dar Reservoir. The budgeted cost of the program, scheduled for completion June 1, 1961, is $7,400,000.

During 1959, a 6-mile, 30-in. crude oil line and a 6-mile, 6-in. products line was built. A 17½-mile, 34/36-in. crude line, the largest in diameter yet laid in Saudi Arabia, was under construction in the spring of 1960 between Qatif Junction and Ras Tanura.

A new plant at Ras Tanura refinery, placed onstream in 1959, produces 1200 b/d of high octane alkylate for blending to make about 2000 b/d of aviation gasoline. It cost $6,800,000.

Reserves: 38.6 billion bbl of oil. This is 1.9 billion more than last year despite high production. Gas reserves are not available.

Consumption: 56,000 b/d including bunkers. Distribution of petroleum products within Saudi Arabia by Aramco estimated at 9000 b/d.

*See *The Petroleum Engineer*, April 1959, page B-36.

SOMALIA

(ITALIAN)

Stanvac is doing gravity work on its 11,740 sq mile prospecting permit in this Italian-administered UN trusteeship in East Africa.

Sinclair Somal (Sinclair and Conorada) abandoned its fourth test well, No. 1 Merca, in the southeast corner of the country, after drilling to about 12,000 ft. The rig was then to be skidded 40 miles north for the next wildcat.

ENI has completed 3 wildcats, all dry.

Others with concessions are Frobisher Oils and a Denver oil man, Merritt C. Orr.

SOMALILAND (British)

Stanvac drilled 3 wells, all dry in 1959. The company has one rig operating on its 11,000 sq mile concession.

BP Exploration Company plans soon to start drilling stratigraphic tests southwest of Berbera where a test was drilled in 1959. It will also make a marine seismic survey off the coast.

SPAIN

(2) R. C. 150,000 b/d
Runs 140,000 b/d

The first full year following passage of Spain's new and apparently workable oil law has stirred exploration in Spain itself as well as in its African territories. These concessions have been granted in Spain: 10 blocks to Esso Iberia covering 805,000 acres; 11 to CIEPSA-Gulf-Deilmann, 647,000 acres; 7 to CAMPSA (state-owned), 547,000 acres; 11 to Iberica (Sun, Union California, et al), 826,000 acres. In February 1960 Phillips was granted permits totaling 1,090,000 acres. The company opened new offices in Madrid and in Las Palmas, Canary Islands.

In 1959 six rotary rigs were operating and 12 wells were drilled; 2 with gas shows and 3 with oil. A possible commercial gas well was reported in by CIEPSA near Vitoria in the province of Alava.

REPESA is expanding its Cartagena refinery by 35,000 b/d crude capacity and a vacuum unit. CEPSA's plant in Canary Islands is adding 40,000 b/d capacity.

Excess of products refined over consumption corresponds to consumption in the Canary Islands, the towns of Ceuta and Melilla, the Spanish Sahara, and Spanish Guinea and also to bunkering in the Canary Islands and the port of Ceuta in North Africa, exports to Morocco and processing agreements operations.

Consumption: 100,000 b/d.

SPANISH GUINEA

Exploration permits for two areas in Rio Muni have been granted CEPSA-Gulf by the Spanish Government, (CEPSA is Compania Espanola de Petroleos, SA). For the first time this small territory below the Cameroons and north of the French Gabon in West Africa will be explored. Spanish Guinea, like Spanish Sahara, attracted interest after the new Oil Law was promulgated.

Nearby on the island of Santa Isabel in Fernando Poo Islands is a bulk storage and distribution plant where capacity is being expanded from 70,000 to 130,000 bbl. In Bata on the mainland is a storage and distribution center of 2800 bbl, which is to be increased to 51,000-bbl capacity.

Consumption: 300 b/d.

SPANISH SAHARA

Spanish Sahara, the Spanish Territory on the west coast of Africa south of Morocco, heretofore little known except for the name, is soon to be a field of intensive petroleum exploration activities.

The promulgation by the Spanish Government of a new petroleum law December 29, 1958, and supplemental government regulations published in the Boletin Oficial del Estado of June 27, 1959, removed some important limitations to foreign capital partici-

pation in petroleum enterprises, including those operating in Spanish Africa. The investment climate of Spanish Africa was further improved by the new Spanish investment law of July 27, 1959.

Late in 1959 several Spanish and American firms* were awarded exploration licenses and three geological and one seismic crew began work but most activity awaited early 1960.

In March Tidewater, as operator of a joint venture with Sohio, announced plans for immediate exploration of permits covering some 5,000,000 acres in the Spanish Sahara. The licensed areas awarded Tidewater and Sohio range from the border of oil-rich Algeria southwestward to the Atlantic Ocean. Preliminary plans call for a base of operations to be established at Las Palmas in the Canary Islands, some 120 miles off the Spanish Sahara coast.

Equipment and supplies were unloaded in northwest Africa in March by Union Oil of California, which appeared to be the first American firm to begin exploratory drilling in the Spanish Sahara. Union and its partner, Compania Iberica de Petroleos, were granted three concessions totaling 1,750,000 acres with Union Oil holding a 70% interest. The first drilling site will be selected immediately after completion of final seismic surveys now underway.

Union's operating headquarters will also be in Las Palmas, one of the only two towns in the Spanish Sahara. Both towns are military garrisons.

A bulk storage and distribution installation is being constructed at the town of Aaiun.

Consumption: 80 b/d.

SUDAN

Geological and geophysical exploration has been going on since October 1959 in the concession along the Red Sea Coast of Agip Minvaria (Sudan) Ltd., (ENI and Republic of Sudan).

Shell is carrying out a geological reconnaissance survey over a 185,000 sq mile area in the northwest after permission was given last September. Both Royal Dutch/Shell Group and AGIP have each offered proposals to the government to build a $17 million refinery at Port Said. No decision has been made by the government.

Consumption: 8000 b/d in 1958.

SWEDEN

(4) R. C. 55,000 b/d
Runs 43,000 b/d

All oil is imported. Local refineries process about one-fifth consumption.

Largest plant is that of Koppartrans (50% owned by Royal Dutch/Shell) at Gothenburg. It now has 30,000 b/d capacity and plans to double this and add the first Swedish petrochemical units. The other three refineries, owned by Axel Johnson and Company are at Nynashamn, at Gothenburg, and at Malma. They have a total of 25,000 b/d capacity. The one at Nynashamn is being enlarged and modernized to a capacity of 40,000 b/d.

Black oils came principally from the Soviet — about 25,000 b/d in 1959 — and the 1960 contract is said to be more. Prices are 10 to 15% below world market rates. A new agreement with Romania calls for oil products in return for Swedish property taken by the state.

Consumption: About the same as 1958 — 195,400 b/d domestic, and 6700 b/d bunkers.

SWITZERLAND

There was some debate over whether Swiss cantons or the federal government should handle oil matters. It appears now these will remain under canton authority.

Petroleum exploration will be undertaken by SEAG in the Kuesnacht area. SEAG with the Germany company Gewerkschaft Elwerath (owning 25%) as operator, expects to have to drill between 20 and 25 test wells to explore its area adequately. La Societe Anonyme de Hydrocarbure of Lausanne is exploring the cantons of Vaud and Neuchatel; d'Arcy Exploration Gaz et Petrole S.A. (BP) is working under contract to a Swiss company in the canton of Fribourg; Swisspetrol, A.G. in the eastern cantons.

Italo-Suisse of Geneva, has purchased a site near Aigle, Switzerland, for 40,000 b/d oil refinery. An oil pipeline to supply the refinery is planned from the Italian port of Pegli near Genoa to a point near Aigle with a possible extension to South Germany. The pipeline is on the program of Oleodotti, a subsidiary of ENI.

Consumption 60,000 b/d.

SYRIA

(UNITED ARAB REPUBLIC)

R. C. 20,000 b/d

Syria had an active oil year in 1959.

In its concession in northeast Syria the Deutsche Erdoel A.G. subsidiary "Concordia" found oil in its exploratory well Souedie 1. It made 700 b/d from 5620-6430 ft on test. Now three rigs are drilling in the area.

The General Petroleum Authority took over the Karatchok field in the same area, which was discovered by Menhall (Mr. Menhall, Atlantic Refining, and Portsmouth Steel). The government compensated the company for 5 wells drilled.

In 1959 Syria opened its first refinery. The state-owned 20,000 b/d refinery near Homs, built by the Czech Technoexport at a cost of $5,500,000, began operating in June. In accordance with the transit agreement made in 1955, part of the crude is being supplied, below posted prices, by Iraq Petroleum from its pipelines which cross the country. Output of the refinery will be about 175,000 tons of motor gasoline a year, 150,000 tons of kerosine, 260,000 tons gas/diesel oils and 378,000 tons of fuel oil. From Homs two 6-in. products pipelines will be built, one running 110 miles north to Aleppo, and one 95 miles south to Damascus. Cost is estimated at $5,600,000. Besides the pipelines the General Petroleum Authority plans to build an $8 million refinery at Latakia, a chemical unit at the Homs refinery, a barrel manufacturing plant; explore for petroleum; and drill oil wells in Karatchok. It is reported the Russians are to build a sulfur extraction plant. Entire program will require about $60 million.

Reserves: Syria's estimate, 280 million bbl.

Consumption: 17,000 b/d.

TANGANYIKA

British Petroleum-Shell drilled a dry hole that went to 13,300 ft. A marine seismic survey was made off the coast of Tanganyika and Kenya.

THAILAND

(SIAM)

(1) R. C. 1000 b/d

The government of Thailand has given permission to Shell to search for oil in the Korat plateau in the northeast of the country.

The Thai Government engaged American contractors to drill in the Bo Ton Kham area to supply the new refinery. Exploratory drilling is scheduled at Ban Huai Bon. The government is having some seismic work done in the Fang Basin and an aerial magnetic survey of the Chao Phraya River Basin.

Thailand's first oil refinery, at Farng in the north of the country, was completed by Refinery Associates of Long Beach, California, under contract to the Oil Fuel Organization in the Ministry of Defense. It has 1000 b/d capacity.

Eastern Petroleum (Standard Oil Indiana) will construct a $35 million refinery with a capacity of 28,000 b/d. The new refinery will be owned by the Oil Fuel Organization and will be leased to and operated by Eastern Petroleum for a period of 10 years.

Another contract has been signed with the Fugi Car Company of Japan for construction of a 5000 b/d oil re-

* For list see *The Petroleum Engineer*, March 1960, Page B-30.

finery at Klong Toey, the Bangkok port site, estimated cost $19 million.

Consumption: 25,000 b/d.

TIMOR

(PORTUGUESE)

Tradewinds Exploration (U.S.) and Timor Oil (Australian) have interests in the 6851 sq mile concession on this east half of the Timor Island north of Australia.

Two wells were drilled in 1959, one to 4600 ft and another to 6755 ft.

Additional geology and gravity work is being done and drilling will begin again after the rainy season.

TRINIDAD

Prod. 112,106 b/d (2) R. C. 187,000 b/d
Gas 251,953 mcf/d Runs 189,600 b/d

The following statistics summarize the overall drilling and producing activities:

	1959	1958
Total crude production, bbl	40,918,786	37,355,059
Average number of drilling strings	30	32
Wells completed	278	295
Producers (oil or gas)	247	256
Success ratio	89.6%	86.7%
Footage drilled	1,446,586	1,365,129

Crude oil and natural gas production in Trinidad in 1959 was:

Company	Crude oil production (bbl) 1959	Natural gas production (MMcf) 1959
Apex	2,926,805	3,479
Dominion	46,594	517
Kern	1,146,809	898
P.C.O.L.	375,192	1,002
Shell	7,435,519	17,683
T.C.O.	1,468,872	8,464
Texaco	17,688,517	40,824
T.N.A.	3,772,423	3,620
T.P.D.	6,056,091	15,476
C. D. Jones	1,964	—
	40,918,786	91,963

Oil output was up nearly 10% and natural gas production increased 16%.

Cumulative production to end of 1959 was: Oil, 667 million bbl; natural gas, 1,084,871 MMcf (est.).

Number of wells producing during December 1959 totaled 3261 and 2198 wells were shut in December 31, 1959.

Wells completed in 1959 were 244 oil wells, 3 gas, and 31 dry for a total of 278.

Texaco plans a $19-million expansion of its 140,000 b/d refinery at Pointe-a-Pierre increasing its daily capacity to 255,000 bbl. New tankage, pipelines, utilities, and jetty facilities also will be added.

Only other refinery is Shell's 47,000 b/d plant, which is running about 47,100 b/d. It is adding a 17,000 b/d capacity in 1960.

Reserves: 425 million bbl.

Consumption: 38,000 b/d.

TRUCIAL COAST

Fujairah. The exploration license for Fujairah, a Trucial Coast shaikhdom on the Gulf of Oman, held by an affiliate of Iraq Petroleum, expired last month, and has not been renewed.

Abu Dhabi. In this shaikhdom IPC is drilling a second well at Murban.

Three concessions are held on the Trucial Coast. Petroleum Development (Trucial Coast), IPC subsidiary, has various land and offshore areas of several small shaikhdoms.

Dubai Marine Areas, Ltd. (BP 66⅔% — CFP 33⅓%) holds continental shelf offshore from Dubai beyond the 3-mile limit.

Abu Dhabi Marine Areas, Ltd. (same ownership as Dubai) has the continental shelf offshore Abu Dhabi beyond three miles.

TUNISIA

Gas 612 mcf/d

Gas production gained slightly over last year. It is produced from small northern fields of SEREPT. This company has kept two rigs going for some years and has drilled 40 dry holes. Recently SEREPT (French 70%, Tunisian Government 30%) made an agreement for Mobil International to acquire a 50% interest in its 10-million-acre petroleum exploration permit.

The permit area is in the southern half of Tunisia, roughly 200 miles from oil production in the nearby Algerian Sahara. Under its agreement with Mobil, SEREPT will continue to hold a 50% interest in the exploration permit and it will be the operator for the two-company exploration program.

Conorada and Rimrock International each have search permits.

Discussions are going on between the Tunisian Government and some local marketing companies on the possibility of building a local refinery. Esso, Mobil, Shell and BP distribute products. The 485-mile pipeline that will carry crude from Edjeleh region, Sahara, to Skirra on the Tunisian Coast, will be completed in October 1960 and could supply the refinery.

Consumption: 8000 b/d oil products.

TURKEY

Prod. 7507 b/d (1) R. C. 6250 b/d
Runs 5500 b/d

Considerable progress was made in 1959 in Turkey. Production rose again — about 7% — and exploration programs are being carried out by a number of firms on the 27 million acres under license.

Turkish Gulf is undertaking airborne magnetometer surveys over the Tuz Golu and Thrace areas. The first airborne geophysical study ever made in Turkey, the survey is being performed by Canadian Aero Service, Ltd. Gulf has four geological parties doing surface work. The company drilled one dry hole.

Atlantic, Tidewater and Texaco-Seaboard have about 3,600,000 acres on which extensive geological and geophysical studies were carried out and several structures have been located. A well drilled in 1958 discovered a natural gas zone, but no oil was found. A second well on another structure was abandoned below 11,650 ft. A number of attractive drilling sites remain to be tested and the evaluation program for the near future will largely involve drilling exploratory wells.

Mobil is operating one drilling rig, three company geological crews, and two contract seismic crews.

Deilmann Petrol and Turkse Shell reached an agreement to pool their exploration of concessions in Thrace. Each conceded the other 50% of its holdings. The companies began a deep test in September at Maltepe 1 with C. Deilmann Bergbau doing the drilling.

Pan American Land & Oil Royalty was granted concessions in Turkey covering nearly a million acres in 1959. This company is an independent Dallas firm. The Turkish concessions comprise 187,740 acres in District V (Siirt) where Turkey's existing oilfields are situated, 481,373 acres in District VI (Gaziantep) where American Overseas Petroleum found oil of 11 API gravity last year at Kahta, and 244,131 acres in District II (Ankara). De Golyer and MacNaughton are making a geological study of the areas.

Emin Iplikci, president of Petroleum Administration, reports a total 31 geological crews and 17 geophysical crews operated in 1959. Of the 34 wells drilled 12 were producers. The 3 small fields now have 47 producing wells. There are 15 rotary rigs operating.

Refining construction made its biggest start in 1959. A $50 million oil refinery at Mersin in southeast Turkey is being built by 3 refining companies associated with Mobil International (56%), Royal Dutch/Shell (27%), and British Petroleum (17%). The Mersin refinery, which will have a ca-

pacity of 65,000 b/d, will be built by Foster Wheeler and is expected to go on stream during the latter half of 1961.

Mobil Oil Turk plans to build two marine terminals to increase its storage capacity by about 68,000 tons. These facilities will take output of the Mersin refinery.

A new company to own and operate the proposed $25,650,000 Istanbul refinery is being formed by Caltex (49%) and Turkiye Petroleri A.O. (51%), Turkish government-owned company. Name of the firm will be Istanbul Petrol Rafinerisi A.S. (IPRAS). Caltex will operate the 20,800 b/d plant 10 years after which TPAO can buy out Caltex interest. Main construction contract for this refinery at Izmit has been awarded to M. W. Kellogg Company. It will have a crude distillation unit, naphtha unifiner, platformer, distillate hydrotreater and fluid catalytic cracker.

A certificate has been awarded MAPER for a 16,000 b/d plant to be constructed at Istanbul. The present Batman refinery of TPAO is being expanded to 12,000 b/d with addition of a thermal cracking unit.

A recent Turk-Iranian agreement provides for construction of an oil pipeline from Kun, Iran, to Iskkenderun, Turkey.

Consumption: 31,000 b/d products, about the same as last year.

TURKS ISLAND

A Standard Oil Company of California subsidiary continued to hold a 165,760-acre license covering land and marine rights on Grand Turk Island. No active exploration was undertaken in 1959.

UNION OF SOUTH AFRICA

(1) R. C. 26,200 b/d
Runs 26,200 b/d

An aerial magnetometer survey was made on the 10,000-sq-mile oil and gas concession in Southwest Africa, which was recently granted Trans-American Mining Corporation, Ltd. a syndicate of American independents.

The concession, announced in mid-July, is the first granted for oil and gas in the Union of South Africa, which controls Southwest Africa. It is in the Namid Desert sedimentary basin on the west coast between Walvis Bay and Luderitz.

Stanvac increased its Durban plant capacity last year and has throughput equal to capacity.

South African Petroleum Refineries Ltd., a new company composed of Royal Dutch/Shell and British Petroleum, plans a 60,000 b/d refinery to be built at Reunion Rocks, near Durban. Approval has been given by the Department of Transport and by the Durban Council, and work on the site is expected to start soon. The refinery will cost about $72 million and is scheduled to come onstream in 1963.

The government plans an oil pipeline.

Consumption: Inland 69,600 b/d; bunkers, 10,000 b/d.

UNITED KINGDOM

Prod. 1700 b/d **(16) R. C. 889,000 b/d**
Gas 66 mcf/d **Runs 784,000 b/d**

A show of oil has been encountered at about 1800 ft in limestone in the Broadbench No. 1 well being drilled near Kimmeridge, Dorset by BP Exploration. Drilling will continue, probably to about 4000 ft.

The Broadbench well is close to a shallow hole drilled before the war. Encouraging oil indications in holes drilled elsewhere in Southern England, decided the company to redrill.

A marine seismic survey in the waters off the southwest coast of the Isle of Wight has been completed, the third marine seismic survey undertaken by BP.

Altogether, 7 rotary rigs operated during 1959, drilling 42 wells of which 22 are producing. This makes a total of 257 producers in U K's small fields.

Refining capacity was expanded 14% in 1959.

Esso's $50 million refinery at Milford Haven came onstream last fall. It includes 100,000 b/d distillation capacity, a hydrofiner and a reforming unit, and has berths to take 100,000-ton tankers.

Now Esso plans a $15.4 million addition to the chemical plant at the Fawley refinery and has planned a 70-mile $2.2 million pipeline from its chemical plant to the new Imperial Chemical Industries plant at Severnside.

Distillation capacity of Shell's "Shell Haven" was doubled to 160,000 b/d by adding a crude oil distilling unit. A sulfur removal plant with a capacity of 16,000 b/d and a bitumen blowing plant were also completed here. The detergent alkylate plant was increased in capacity.

Shell Chemical will build a synthetic rubber plant at Carrington, Lancashire.

Witco Chemical (U.S.) plans a synthetic production plant in the Midlands.

British Hydrocarbon Chemicals Ltd., (BP and Distillers Company), has plans to build three new major plants at its works at Grangemouth, in Scotland. One of the plants will more than double the existing capacity for the manufacture of butadiene. The other two new plants are for the manufacture of methanol and ethylene dichloride. It is planned to commission each of the three new plants during 1961. Total investment in the three is approximately $14,000,000.

Imperial Chemicals is setting up a new complex of petrochemical plants, to be known as Severnside Works, on a 1000-acre site near Avonmouth in South Gloucestershire, on a pattern similar to that of the company's large petrochemical works at Wilton, Yorkshire. The first should go onstream in two years' time. There will be facilities for making up to 35,000 tons a year of ethylene oxide and ethylene glycol. Main raw material, ethylene, is to be supplied by Esso from its petrochemical plant at the Fawley refinery near Southampton.

The Gas Council of the nationalized gas industry is considering construction of one or two special ships totaling 20,000 tons to import liquid methane gas. An experimental ship has made three successful voyages and will make several more.

The Regent Oil Company plans an oil storage terminal for over 30,000 tons capacity at Granton Harbor, Edinburgh.

Construction of Britain's longest crude oil pipeline was completed last fall. Running for over 60 miles across South Wales, the 18-in. line links BP's tanker terminal, now being built near Angle Bay, Milford Haven, with the company's Llandarcy refinery, near Swansea. The pipeline is capable of carrying 100,000 b/d crude oil.

Reserves: Small.

Consumption: 740,000 b/d, a gain of 16% above 1958.

UNITED STATES

Prod. 7,034,000 b/d **R. C. 9,803,750 b/d**
NGL 875,000 b/d **Runs 7,983,000 b/d**
Gas 34,084 m^2cf/d

The U.S. industry made strong gains in 1959. Crude production was up 4.8%; natural gas production rose 8.3%; refining runs increased 5%.

Drilling did not move up as much as expected. Outside of service wells, there were under 50,000 wells by rotary drilling rigs. Over 20% were exploratory. Some 2169 rotary rigs were in operation at the end of the year. Increase in reserves were larger than drilling indicated.

Bureau of Mines pipeline survey completed October, 1959, showed these mileages as of January 1, 1959: Crude gathering lines, 75,182 miles; crude oil trunk lines, 70,317; refined products lines, 44,483 miles; gas lines (transmission and distribution mains), 595,-600 miles at end of 1959.

Refining capacity is slightly under last year. Evidently most capital expenditures were devoted to moderniza-

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tion since only 81.4% capacity was in use in 1959.

Reserves: Crude oil, 31,719 million bbl and gas liquids, 6522 million bbl, both hitting a total of 38,242 million bbl, highest in history. Natural gas reserves are 263 trillion cu ft, the all-time high.

Demand: Total demand was 9,748,000 b/d with domestic demand at the high of 9,516,000 b/d.

URUGUAY

(1) R. C. 27,000 b/d
Runs 21,700 b/d

ANCAP, state-owned company has one drilling rig in operation and drilled four dry holes in 1959.

ANCAP's refinery at La Teja, Montevideo began operating a new topping tower early in 1960. This and other additions built by M. W. Kellogg are scheduled for completion late this year. Capacity will be 45,000 b/d.

Consumption: 25,500 b/d, up 3% from 1958.

USSR

Prod. 2,590,000 b/d R. C. 2,400,000 d/b
Gas 3,599,000 mcf/d Runs 2,300,000 b/d

Russia's oil industry continued its rapid growth during 1959, setting new records in nearly all phases of development. As a result, Soviet planning officials now regard 1960 as the year when the USSR will become the world's second largest petroleum producing nation — displacing Venezuela.

Topping the list of Russian achievements last year was a 14% gain in crude production. Output totaled 129.5 million metric tons, against 113 million in 1958 and only 98.3 million in 1957. Production goal for 1960 is 144 million metric tons.

In contrast to crude production, where the government's 1959 goals were exceeded, Russian natural gas output lagged behind plan.* Nevertheless, the USSR boosted gas production 25% to 37.2 billion cu m (1,313.7 billion cu ft) last year, compared to 29.8 billion in 1958 and 20.2 billion in 1957. Target for 1960 is 53.2 billion cu m.

Of more immediate significance for the free world than Russia's oil and gas production gains was its huge increase in petroleum exports last year and its vigorous search for new markets. Soviet Minister of Foreign Trade N. Patolichev reported that Russian crude and products exports in 1959 reached 25 million metric tons, (500,000 b/d) compared with 18,138,000 tons in 1958, a 38% increase. Whereas Soviet crude and products exports were almost equally divided in 1958, crude deliveries are now believed to be substantially larger than products shipments. (Editor's note: All these Soviet figures make us wonder about energy for a better domestic living standard. Exports have gone up more than output.)

Russian capability for delivering oil to any overseas point is also expanding markedly. In January 1960, the USSR commissioned its first 40,000-ton, 18-knot tanker — the "Peking." Another tanker of the same class was launched last year, and a third is under construction at Leningrad.

Despite the large jump in exports, Russia's own consumption of petroleum products continued to rise. In 1958, Soviet crude production of 113 million metric tons plus crude and products imports of 4,296,000 tons, less exports of 18,138,000 tons, left a net balance of 99,158,000 tons for domestic use. Last year, despite substantially-higher exports, the USSR is estimated to have had over 180 million metric tons of oil available for home consumption. (Only 9% rise.)

Refinery capacity is increasing every year but is believed to be growing at a slower rate than crude production. Frequent complaints appeared in the Soviet press during 1959 about serious lags in construction of new refineries at Polotsk in eastern Russia, at Ryazan, southeast of Moscow, at Yaroslavl, northeast of Moscow, and at Krasnoyarsk in central Siberia.

Nevertheless, the USSR State Planning Committee has promised that there will be no shortage of oil products for essential purposes in the Soviet Union during 1960 and that larger supplies will be available for the consumer market. It said that additional refining capacity will provide a 15% increase in diesel fuel production and a 9.3% increase in light oil products this year.

Transportation remains a major bottleneck for both the Soviet oil and gas industries. New crude and products pipeline activated last year came to little more than 1242 miles, while new gas transmission lines totaled 2298 miles. Plans call for construction of about 1300 miles of crude and products lines and around 2300 miles of gas transmission lines during 1960.

Russia will continue to push work this year on its 2300-mile, trans-Siberian crude line from the "Second Baku" fields west of the Ural Mountains to the central Siberian industrial center of Irkutsk. Progress is also anticipated on the important 700-mile products line from Kuibyshev, on Volga River to Bryansk, southwest of Moscow.

Natural gas lines slated for activation this year include: Karadag (Caspian Sea Coast)-Erevan, Armenia (already completed); Samarkand-Tashkent; Stavropol (northern Caucasus)-Moscow (second line); Saratov-Gorky; and Dashava (Carpathian Mountains)-Minsk. A start will be made on the 40-in. line to be built from Uzbekistan's enormous Gazli field northward to Chelyabinsk in the Ural Mountains — a distance of 1118 miles, with completion scheduled in 1963.

Success in finding both oil and gas during recent years has led the Russian press to proclaim confidently that the USSR has "colossal potential oil and gas reserves which significantly exceed those of the United States." To prove that such statements are more than idle boasts, the government is appropriating ever-larger sums for exploration over a vast area of the Soviet.

The Russians are especially optimistic that they will find large new oil and gas reserves in Turkmenia and Uzbekistan, both east of the Caspian Sea, and in the depression north of the Caspian Sea on both sides of the Volga River delta. Exploration will also be intensified in Siberia, where there have been gas strikes but where the hunt for oil has been discouraging.

Biggest concentration of both exploratory and development drilling in the early 1960s will remain in the "Second Baku" region between the Volga River and Ural Mountains.

Russian oil and gas well footage is due to hit a new peak during 1960. Plans call for a total of 27,415,000 ft of hole, around 7000 wells, compared with 25,403,000 ft in 1959. Almost all the gain will be in exploratory drilling.

Number of rigs in operation is expected to vary little from 1959, with the footage increase to be achieved through replacement of old units with new, more efficient ones. Deepest drilling will continue to be in Azerbaijan, where plans have been developed for a 7000 meter hole on the Apsheron Peninsula east of Baku.

Reserves: 58 billion bbl oil; 120 trillion cu ft gas.

Consumption: 2,130,000 b/d oil products.

VENEZUELA

Prod. 2,771,000 b/d (14) R. C. 840,000 b/d
Gas 3,000,000 mcf/d Runs 810,000 b/d

A National Petroleum Corporation was organized and promulgated on April 19. Details made public indicate that the corporation will be owned

* See "The Soviet Gas Goof," *The Petroleum Engineer*, April 1960, Page E-2.

"... thinking about big business based on myth or on conditions that no longer exist, or actions that spring from insufficient understanding, bias, emotion, or political opportunism, can do immense harm to our country, and can adversely affect the fortunes of the average citizen."

– M. J. Rathbone, President

ESSO

Standard Oil Company (New Jersey)

wholly by the government and will enter into all phases of the industry, such as exploration, manufacturing, refining, and transporting hydrocarbons, and marketing products in or out of the country.

Venezuelan petroleum production averaged 2,867,298 b/d in January, a decline of 4.22% from the corresponding period of 1959. Drilling in the week ending January 27 averaged 58 wells, compared with the weekly average of 80 wells in 1959 and 127 in 1958.

The downward trend in drilling activities is attributed to the discouraging tax situation. The last tax revision in December 1958 was made by the Junta. Under its provisions the surtax was raised from 26 to 45%. This changed the 50-50 formula to 65% for government and 35% for the companies.

Production rose 6% higher than 1958 but prices failed to hold to that level. Below is production by companies:

Companies	*B/D, 1959*
Creole	1,108,300
Shell	797,700
Meneg.	370,600
Mobil	114,600
Texas	55,900
Richmond	49,800
Sinclair	46,500
Ven-Sun	43,900
San Jacinto	34,800
Petmer	31,900
Phillips	29,100
Varco	25,900
Signal	24,700
Colon	19,900
Superior	16,100
Talon	1,300

It was not until February 1960 that a labor contract was signed with oil companies. Covering about 45,000 workers the new contract obtained greater benefits in most significant features — higher pay, reduced working hours, guarantee by companies of contractor and subcontractor employee benefits. Cost to industry during 3-year contract is estimated at $100 million.

President Betancourt announced that no further petroleum concessions would be granted private industry during his administration.

Authorities seem willing to sit on the situation as is. Dr. Juan Pablo Perez Alfonso, Minister of Mines and Hydrocarbons, at a TIPRO (Texas independents) meeting in May spoke out for conservation and reasonable production increases. He is for world proration and has had as a consultant, an expert from the Texas Railroad Commission to advise on prorationing.

In 1959, oil industry earnings dropped 22% to $377 million. The government's take decreased 15% to $781 million. Capital outlays by industry went to $335 million, down 37% from 1958.

In 1958 about 1150 wells were drilled and 108 rigs were active. In 1959 about 50 rotary rigs were operating and about 550 wells were drilled.

A $30,000,000 oil refinery at El Palito, Venezuela, has been placed in operation by a Mobil International affiliate. On the Caribbean Coast near Puerto Cabello, it has a capacity of 50,000 b/d. It processes crude oil from Barinas Province, in southwestern Venezuela, to which it is linked by a 210-mile pipeline.

This is the only new refinery but Gulf is adding 65,000 b/d crude capacity at its Puerto la Cruz plant; Richmond 5000 b/d at its Bajo Grande plant, now 30,000 b/d. Shell added a third crude oil distilling unit at Cardon to expand capacity from 40,000 to 60,000 b/d.

The second naphtha fractioning unit at Creole Petroleum's Amuay refinery has now gone into operation. Cost of the new plant was about $3.6 million. This second installation has a capacity of 10,500 b/d while the first plant put in service processes 18,700 b/d.

A 70-mile, 30-34-in. crude oil pipeline was completed from Lake Maracaibo fields to Puerto Miranda, where a big new loading terminal was built.

The new gas pipeline Anaco-Caracas was put in service early last July. The pipeline is part of the Anaco-Caracas-Moron-Barquisimeto system, which continues on to the oil fields of Bolivar District in Zulia State, which will supply gas for industrial and domestic use in central and western Venezuela. It it the first link in the planned network of national gas pipelines, in a government program to be carried out at an estimated cost of $448 million. The total extension will be of about 1000 miles.

The first section now in service is 26-in. pipe about 200 miles long. From now on, the large thermo-electric plant at La Mariposa, near Caracas, will operate on gas from the new pipeline.

Reserves: 17,500 million bbl; natural gas, 33 trillion cu ft.

Consumption: Petroleum industry 12,000 b/d; domestic use, 74,500 b/d; bunkers, 50,000 b/d.

YEMEN

BP Exploration has suspended work on its concession and American Overseas Investment, which holds 10,000 sq miles on the northwest coastal plains and offshore, has not been active.

Reformer stabilizer tower at new 50,000 b/d refinery of Mobil Oil de Venezuela at El Palito. Photo from M. W. Kellogg, contractor.

YUGOSLAVIA

Prod. 17,000 b/d **(3) R. C. 23,000 b/d**
Gas 4770 mcf/d **Runs 21,000 b/d**

A new major oil discovery near Sisak in Croatia encourages the Yugoslavic industry. It appears to be the largest oil deposit yet found in the country.

Most production comes from northeast Yugoslavia, including the Sava Basin, where the new discovery was found at Popovaka. This area also has important gas production.

The country's three refineries are at Sisak (12,000 b/d capacity), Bosanska Brod (2000 b/d) and at Rijeka (9000 b/d). These are to be expanded and, according to plans, a fourth refinery constructed.

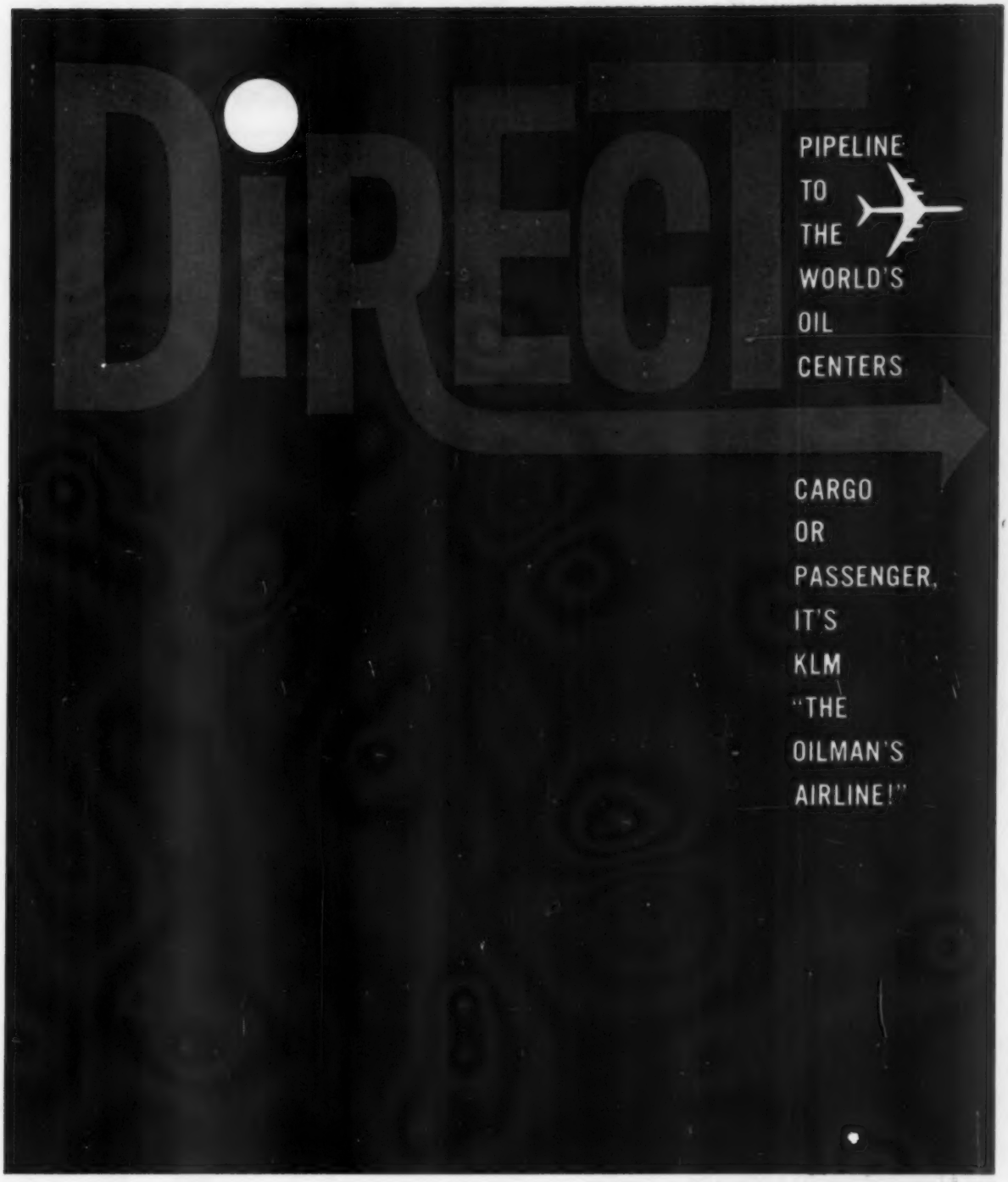
Reserves: 40 million bbl oil.

Consumption: 22,000 b/d and all gas output. Demand has increased steadily.

ZANZIBAR

No activity in 1959 on the only concession, which is held by BP-Shell.

* * *



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Industry Sits on Dead Center

First quarter reports reveal slight change compared to 1959

AN ERRATIC FIRST QUARTER in the petroleum industry indicates the industry began 1960 almost dead center with companies wobbling toward plus or minus changes in revenues and earnings.

The group listed in the table showed a 1% decrease in earnings compared to 1959. However, the 1959 first quarter had leaped 21% higher than 1958 so this year makes a good record compared to two years ago.

Revenues continued to increase. The 1960 first quarter was 2% above last year.

Surprising perhaps, but capital expenditures showed strength despite slow markets. Union of California spent $33 million on capital facilities in the first quarter, 22% over 1959 first quarter. Ohio Oil spent $11 million, up 20%. Conoco spent $37 million, an increase of 76% from 1959. Shell capital expenditure rose 40% to $86 million; Tidewater spent $30 million, 53% up from 1959.

Several revised upward estimates of capital expenditures for 1960. Announcements were made by Sohio* that the company would spend 10% more than last year's $40 million; by Aztec* that it would spend $6 million, and by Phillips Petroleum* that it would spend $175 million.

As in profits there are those on the other side. Richfield's expenditures dropped 24% to $8 million this year. Atlantic said it was revising downward capital expenditures to live within planned indebtedness. Jersey Standard's capital and exploration outlays were 7% under the 1959 first quarter.

Texaco revealed it will spend nearly $23 million for research, about three times the level of 1950.

Recent political tensions remind us that a healthy oil industry is vital to the security of our country. The oil industry is carrying a double burden of excess capacity and discriminatory taxation but the steadfastness of its planning and its expenditures clearly show it is riding this situation through and is prepared for emergencies at the same time.

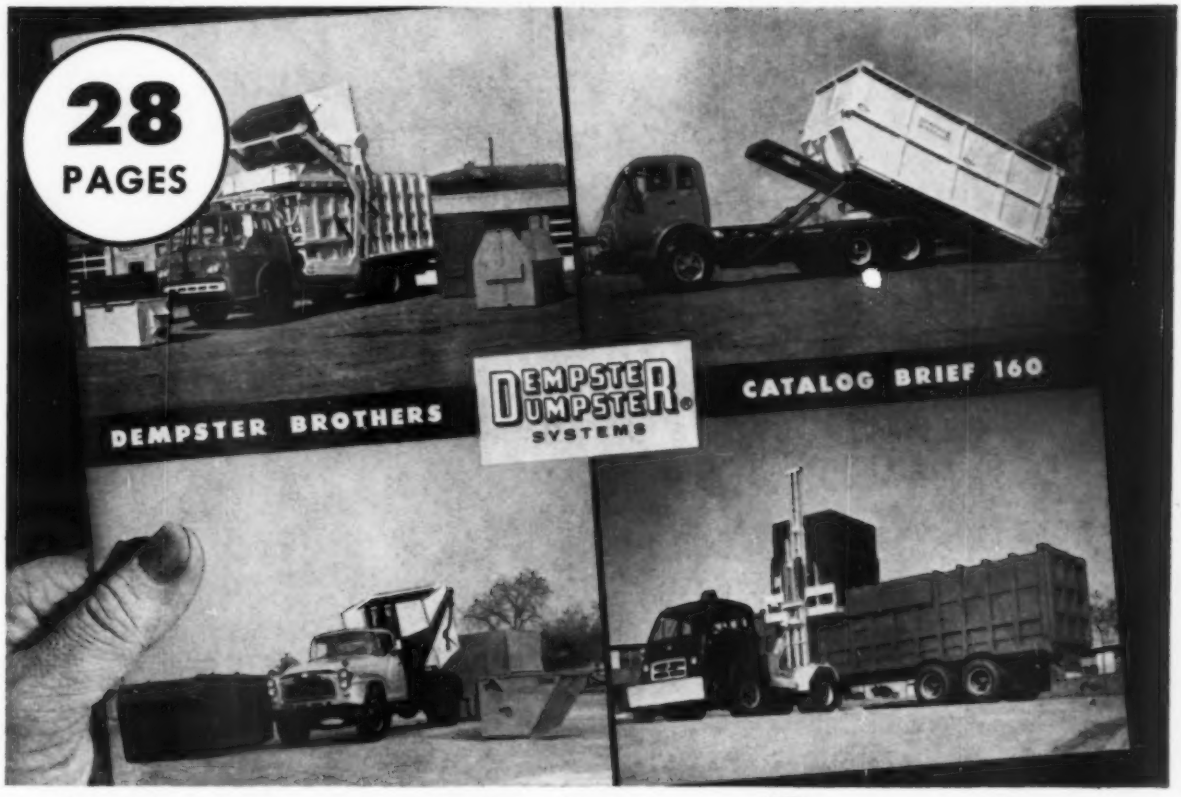
* Our estimates in annual survey in *The Petroleum Engineer*, May 1960 were all less than these figures.

FIRST QUARTER STATEMENTS OF PETROLEUM COMPANIES

Company	Gross ($1000) 1959	Gross ($1000) 1960	Percent Change	Net ($1000) 1959	Net ($1000) 1960	Percent Change
Amerada Petroleum	27,707	27,313	— 1	6,383	6,473	+ 1
Ambassador	1,226	1,660	+35	77	513	+565
Anderson-Prichard	17,908	17,812	— 1	1,347	1,352	0
Argo Oil Corp.	3,509	3,644	+ 4	1,545	1,144	— 26
Ashland Oil & Ref.	79,613	78,067	— 2	3,933	3,409	— 13
Atlantic Ref.	156,881	154,307	— 2	12,346	8,726	— 39
Aztec Oil & Gas	1,915	2,237	+17	1,270	1,416	+ 12
Bishop Oil Company	505	502	0	5	28	+460
Champlin O. & R.	20,667	20,361	— 2	2,224	1,860	— 16
Cities Service	282,762	265,791	— 6	13,661	12,974	— 5
Coastal States[5]	3,089	5,256	+70	1,218	2,054	+ 69
Colorado O. & G.	10,317	10,994	+ 7	426	(180)	—
Continental Oil	193,411	200,326	+ 4	14,906	15,280	+ 3
Crescent Petroleum	—	—	—	686	714	+ 4
Delhi-Taylor	22,600	25,900	+15	2,500	1,400	— 44
Eason Oil Co.	1,022	1,020	—	193	174	— 10
Frontier Refining	7,252	6,234	—14	170	388	+170
General American	6,733	7,528	+12	1,256	(32)	—
Getty Oil Co.	10,340	10,584	+ 2	2,577	2,923	+ 9
Gulf Oil Corp	—	—	—	66,673	81,824	+ 23
Helmerich & Payne[4]	3,130	4,325	+38	(77)	336	—
Honolulu Oil	11,294	12,024	+ 6	3,485	3,259	— 6
Hugoton Producing	2,620	2,701	+ 3	1,299	1,343	+ 3
Kerr-McGee[5]	—	—	—	4,644	5,388	+ 16
Leonard Refineries	15,211	14,053	— 8	336	418	+ 24
Louisiana Ld. & Exp.	8,618	11,030	+28	4,264	5,604	+ 31
Macmillan Pet.	3,537	3,229	— 9	91	106	+ 16
Midwest Oil	5,133	5,186	+ 1	1,596	1,817	+ 14
Monterey Oil	11,832	10,919	— 8	1,242	971	— 22
Murphy Corp.[2]	11,411	14,945	+31	1,144	1,135	— 1
Ohio Oil Co.	75,165	92,054	+22	10,198	10,279	+ 1
Phillips Petroleum	299,825	301,427	+ 1	38,621	37,799	— 2
Plymouth Oil	—	—	—	1,527	282	— 82
Producing Properties[1]	3,840	4,521	+18	162	825	+409
Pure Oil Co.	155,688	165,131	+ 6	5,591	5,766	+ 3
Quaker State	14,457	12,732	—12	448	401	— 10
Richfield Oil	5,585	6,995	+25	83,609	86,578	+ 4
Shamrock O. & G.[2]	13,587	15,202	+12	2,362	2,085	— 12
Shell Oil Co.	452,218	457,554	+ 1	34,467	34,545	0
Signal Oil & Gas	38,100	60,000*	+57	4,300	3,400	— 20
Sinclair Oil	337,249	334,303	— 1	17,184	12,308	— 28
Skelly Oil Co.	68,814	65,340	— 5	6,598	5,909	— 10
Socony Mobil	—	—	—	45,200	47,200	+ 4
Standard Oil Calif.	447,247	479,598	+ 7	57,597	60,728	+ 5
Standard Oil Ind.	520,205	514,852	— 1	44,684	31,689	— 29
Standard Oil N. J.	2,156,000	2,212,000	+ 3	214,890	216,533	+ 2
Standard Oil Ohio	92,800	93,100	0	5,096	5,066	— 1
Sun Oil Co.	203,099	182,806	—10	11,227	8,790	— 22
Sunray Mid-Continent	119,968	144,126	+20	9,711	9,440	— 15
Superior Oil[1]	70,858	61,849	—13	16,207	12,493	— 23
Texaco Inc.	—	—	—	93,828	97,313	+ 4
Texas Gulf Prod.	4,445	4,162	— 6	1,219	1,218	0
Texas Pacific	6,721	6,730	0	2,021	2,104	+ 4
Tidewater Oil	139,055	143,700	+ 3	10,463	5,932	— 43
TXL Corp.	—	—	—	1,149	822	— 29
Union Oil Calif.	118,648	123,209	+ 4	4,890	5,530	+ 13
Universal Consol.	2,003	1,878	— 6	780	676	— 13
Wilcox Oil	2,183	1,407	—36	216	246	+ 14
TOTAL	6,268,003	6,402,424	+ 2	874,138	868,492	— 1

* Acquired Eastern States Petroleum & Bankline Oil during 1959.
[1] for 6 mo. ending Feb. 28 and 29.
[2] for 3 mo. ending Feb. 28 and 29.
[3] for 3 mo. ending Jan. 31.
[4] for 3 mo. ending Dec. 31.
[5] for 9 mo. ending Mar. 31.

NEW CATALOG Describes Latest Developments in Waste and Refuse Storage and Removal



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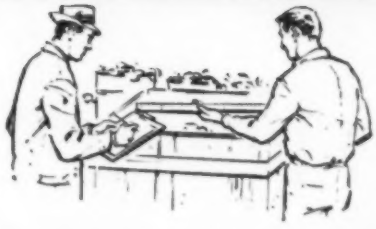

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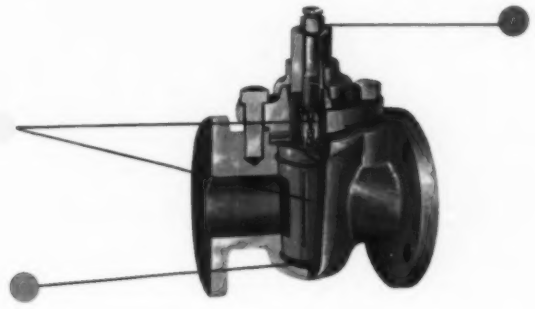
The Chinese had water distribution systems centuries ago. "Pipes" were sections of bamboo continuously spouting water. While date or inventor is not certain, one of the earliest valves was made by boring a hole in a plug and fitting it into holes cut in the bamboo pipe.

he stopped a trickle of water

. . . and his idea helped give you a better valve

One of the first known valves, a plug cock invented by the Chinese, had two inherent advantages never equalled by any other type of valve: *simplicity in construction and operation.* It controlled flow with only one moving part, the rotary plug.

To these basic advantages, the modern Rockwell-Nordstrom valve adds a third: *pressurized lubrication.* Pressurized lubrication totally seals the valve against leakage and maintains an instantly renewable seat. It also reduces wear and assures easy operation. And because there are only three basic parts – plug, body, and cover – you get longer life and lower cost—"The fewer the parts, the fewer the repairs." For more advantages of the Rockwell-Nordstrom valve, see the illustration below.



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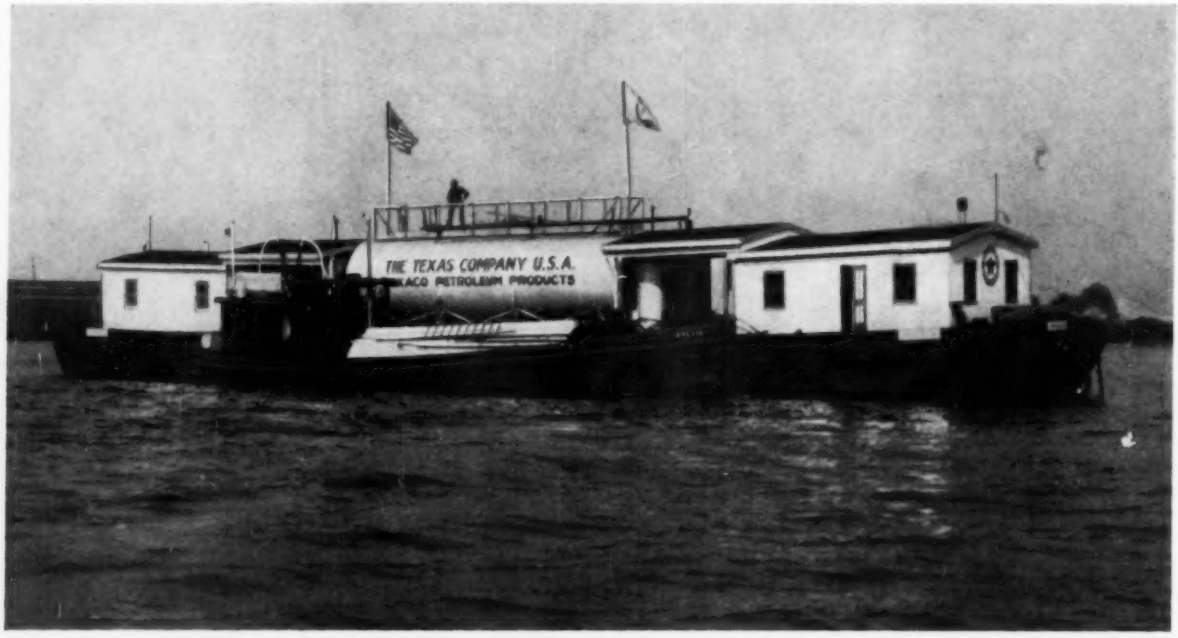

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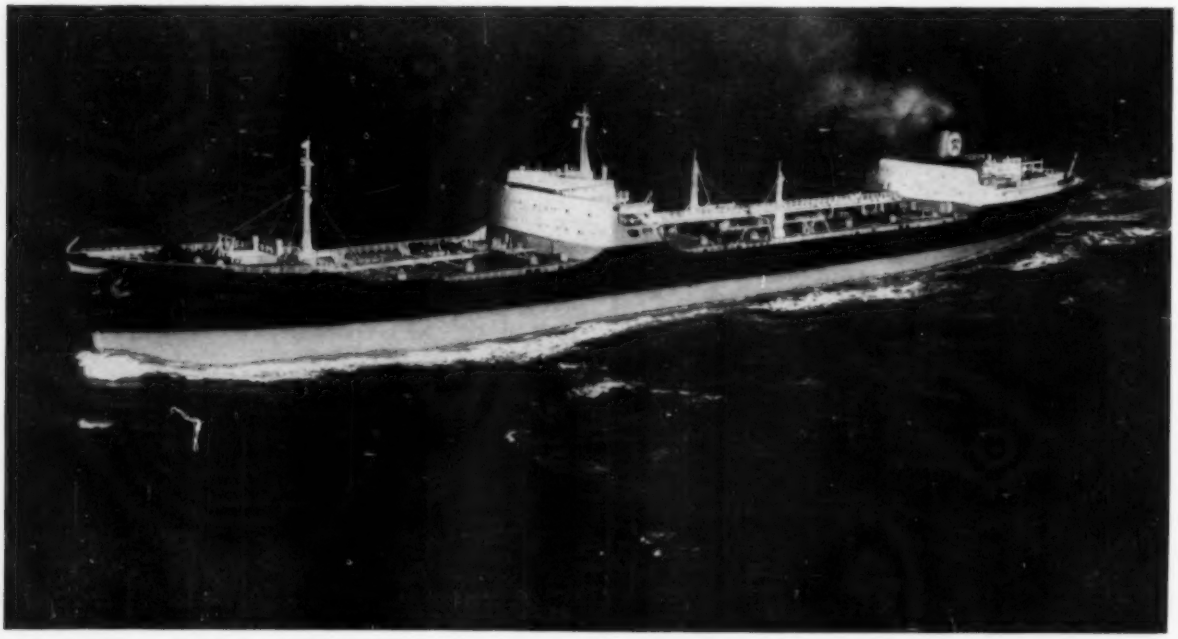

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QUICK-CHANGE ATTACHMENTS. Multiply the usefulness of these machines. Attachments available include the Side Dump Bucket, Rock Bucket, Quarry Bucket, Bulldozer, Ripper and Log and Lumber Forks.

Management Personals

▸ **L. M. Ream Jr.** was appointed manager of the economics department of Atlantic Refining Company. He succeeds **Dr. D. C. Hamilton,** who is leaving the company to accept a position on the teaching staff at the University of Chicago.

Also announced was the new name of the economics department — coordinated planning and economics department.

▸ **Howard Elrod** was named in charge of Pelican Machinery Company of Shreveport, distributor for northern Louisiana of Koehring Division of Koehring Company. The new distributorship will be under the same general management as Pelican Machinery Company of New Orleans, Koehring Division distributor for southern Louisiana, but will operate as a separate entity.

▸ **Albert C. Moeser** of Birmingham, Alabama, was appointed sales representative in the Southeastern area covering the states of Alabama, Georgia, Florida, Mississippi and South Carolina for Victaulic Company of America.

▸ **W. J. Carthaus,** president and chief executive officer of the Great Northern Oil Company, announced that **Marlin E. Sandlin** of Houston, Texas, formerly vice president and general counsel for the company, was elected chairman of the board of directors.

He replaces **J. R. Parten,** also of Houston, who has retired. Parten is former president of Woodley Petroleum Company. Carthaus also announced that **Randall G. Dunn** of Wichita, Kansas, was elected to the board of directors.

▸ **K. W. Brill,** Denver, Colorado, was promoted to vice president and general manager of Continental Oil Company's Rocky Mountain region. Formerly vice president and assistant general manager of that region, he will continue to make his headquarters at Denver and succeeds **J. W. Liddell,** retired. **E. L. Shafer,** Calgary, Alberta, vice president and production manager for Hudson's Bay Oil and Gas Company, Ltd., an affiliate of Conoco, succeeds Brill.

D. R. Johnson, Houston, was elected vice president. He is general manager of the manufacturing department. **C. E. Greenwood,** also of Houston, was promoted to administrative assistant to the president. He had served as division geologist for the Gulf of Mexico division.

C. K. Shepherd, New York City, was promoted to general manager of Conoco's central region, with headquarters at Oklahoma City. Formerly manager of acquisitions in the foreign department, he succeeds **Hal F. Nabors,** who recently transferred to New York as manager of production in the company's foreign department. **R. G. Parker,** Oklahoma City, is named assistant general manager of the central region. Formerly central region production manager, he will continue to make his headquarters in Oklahoma City.

M. J. Rathbone

Eugene Holman

▸ **Monroe Jackson Rathbone,** president of Standard Oil Company (New Jersey), was named chief executive officer and chairman of the executive committee. He retains the presidency, a post held since 1954 and succeeds as chief executive officer **Eugene Holman,**

L. D. Welch

M. A. Wright

board chairman, who retires. Succeeding Holman as chairman of the board of directors is **Leo D. Welch,** an executive vice president, who joined Jersey as treasurer in 1944 after a 25-year career in foreign banking. Welch will be vice chairman of the executive committee. **M. A. Wright,** a director since 1958, was elected an executive vice president and a member of the executive committee.

▸ **Ford M. Graham,** formerly vice president of Monterey Oil Company, was elected a vice president of The Louisiana Land and Exploration Company.

▸ **Lincoln Atkiss** was named director of marketing personnel, Atlantic Refining Company. He succeeds **F. N. Mann** who was recently named manager of the firm's purchasing department. Atkiss has been director of the executive and supervisory personnel inventory program since 1953.

▸ **Fred G. Crosby** was elected vice president of Sun Oil Company, Ltd. In March 1959, he was elected a member of the company's board of directors. In 1956 he became general sales manager, a post he continues to hold.

Sun Oil Company promoted three vice presidents to newly-created senior posts and elected three additional vice presidents. The senior vice presidents who retain full authority over their departments, are: **John G. Pew,** previously vice president in charge of production; **Clarence H. Thayer,** previously vice president in charge of manufacturing and of research and engineering; and **Willard W. Wright,** previously vice president in charge of marketing.

The newly-elected vice presidents are: **Thomas S. Horrocks,** vice president in charge of all marketing activities, previously general sales manager; **Chalmer G. Kirkbride,** vice president in charge of research and engineering, previously executive director of those functions; **Kingsley V. Schroeder,** vice president in charge of domestic and Canadian production activities, previously director of production. **Wilburn T. Askew** was elected vice president in charge of refineries and will continue in that capacity in the new organization.

The board also elected **William S. Woods Jr.** as a second assistant secretary and treasurer. He was manager of the financial and corporate stock division of the treasury department.

The Board also re-elected **Joseph N. Pew Jr.** as its chairman, **Robert G. Dunlop** as president, **John C. Agnew** as secretary-treasurer, **Donald P. Jones** as comptroller, and **Joseph T. Wilson Jr.** as assistant secretary-treasurer.

▸ **H. Walton Musick,** manager of the office services department, was appointed assistant director of purchases of Kerr-McGee Oil Industries, Inc. **John D. Raunborg,** manager of internal auditing, was named assistant to the controller. Succeeding Raunborg is **W. Wayne Roberts.**

▸ **Leonard R. Seaman,** president of Intex Oil Company, received the "Man of the Year" award from Bakersfield Desk and Derrick Club at its sixth annual golden Derrick Ball, April 30. This is the award presented each year to a San Joaquin Valley oil man in recognition of outstanding achievement.

▸ **Carl E. Totten** was named public relations manager for Shell Oil Company in Los Angeles. He replaces **J. H. Sembower,** who resigned. For the past five years Totten has served as manager of news and information in Shell's head office public relations department in New York.

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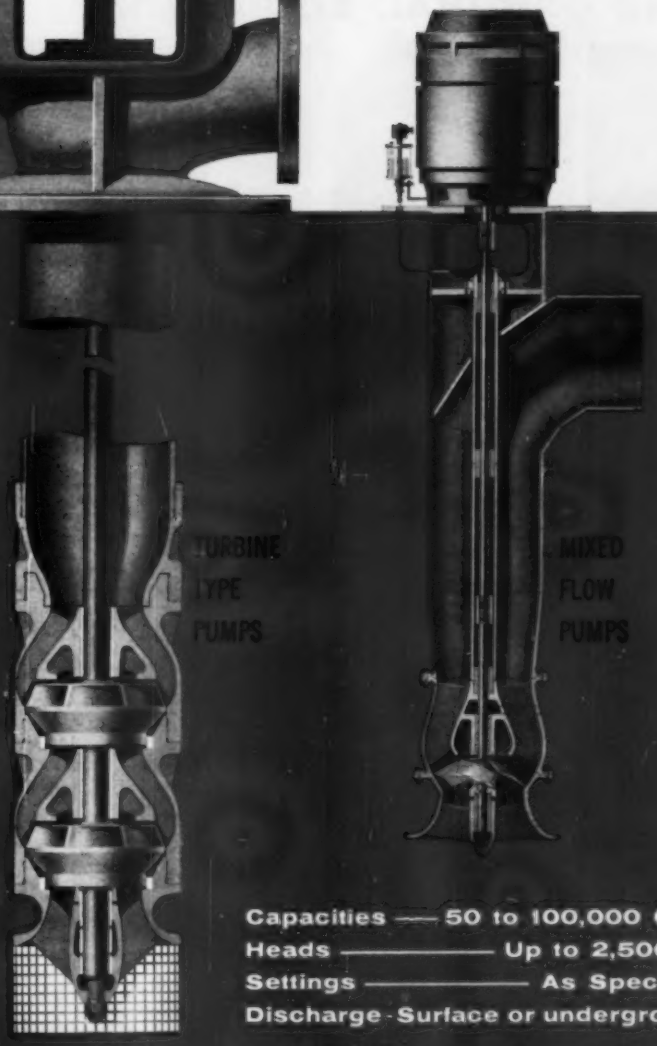

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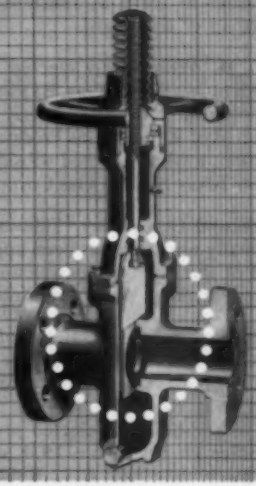

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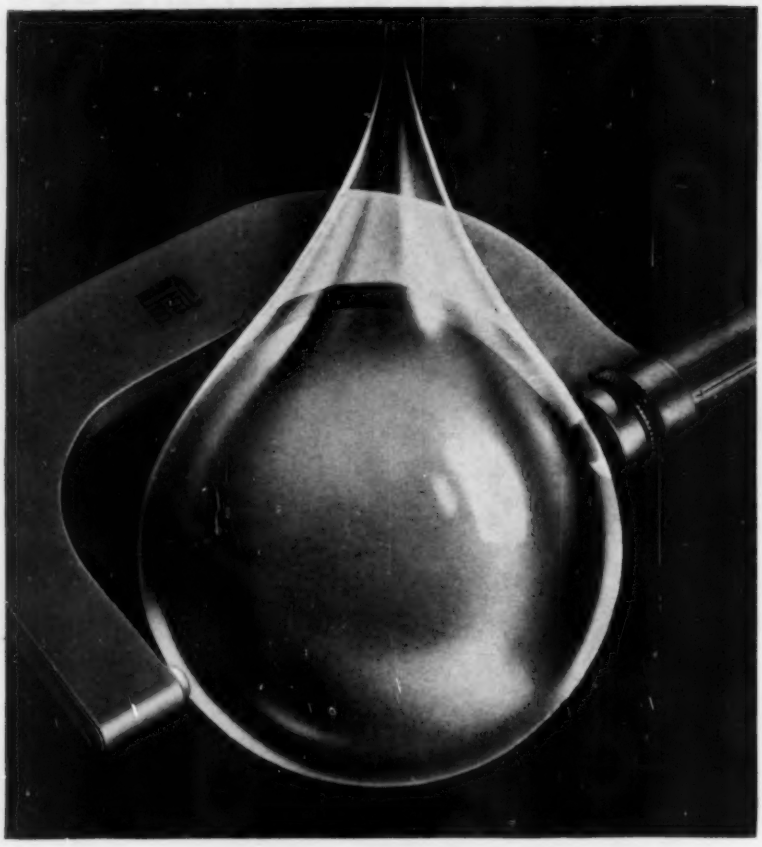

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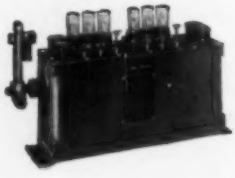

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▸ **John E. Swearingen,** president of Standard Oil Company (Indiana) was elected to the board of trustees of Carnegie Institute of Technology.

▸ **William B. Billock** was appointed director of employee relations for Gulf Oil Corporation. **V. H. Ludwig,** vice president in charge of organization planning and employee relations, has retired with 40 years' service.

▸ **M. R. Bridgeman** was appointed chairman of The British Petroleum Company, effective with the retirement of **Sir Neville Gass** June 30. **J. M. Pattinson** is to be a deputy chairman. **M. A. L. Banks** is to be named to fill the vacancy on the board.

▸ **Howard S. Gleason** was appointed assistant to the president of Southwestern Industrial Electronics Company, a division of Dresser Industries, Inc. Gleason, who came to SIE from Stromberg-Carlson, served there as assistant general manager of the electronics division.

▸ **T. M. Thompson** was elected president of General American Transportation Corporation. He replaces **W. J. Stebler,** who has served as president for the past six years. Stebler will remain on the board of directors and continues to serve as assistant to the chairman of the board.

▸ **W. H. Woods** was elected a vice president of Texas Gas Exploration Corporation. He was formerly a vice president of Runnels Gas Products Corporation, a wholly owned subsidiary of Union Texas Natural Gas Corporation.

▸ **Edmund D. Buckley,** Tidewater Oil Company attorney, has been appointed head of the Flying A petroleum firm's western division legal department.

▸ Changes among top officers of Union Oil Company of California are: **Reese H. Taylor,** chairman of the board since 1956, was re-elected to that position and in addition was elected president, an office he held from 1938 until he was made chairman; **A. C. Rubel,** president since 1956, retired but will continue active association with the corporation as a director and member of the executive committee; **Dudley Tower,** senior vice president, was elected executive vice president and will continue to serve as a director and member of the executive committee; **John W. Towler,** director of manufacturing, elected a vice president; **N. T. Ugrin,** director of industrial relations, elected a vice president; **Morley E. Joyce,** supervisor of financial accounts, elected assistant comptroller, succeeding **R. E. Dalbeck** who becomes director of the budget control department.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

▸ **Robert B. Irons,** assistant advertising manager, was promoted to advertising manager, Standard Oil Company (Indiana), succeeding **Wesley I. Nunn,** retired. **Karl Mueller,** district manager at Saginaw, Mich., succeeds Irons.

▸ **A. C. Mattei** has resigned as chairman of the board of Honolulu Oil Corporation but will continue to serve as a director of the company.

▸ **Herman G. Gunter** was elected vice president and general manager of refinery operations of Commonwealth Oil Refining Company, Inc. He was previously assistant refinery manager.

H. G. Gunter

Harris Bateman

▸ **Harris Bateman** of Bartlesville, Okla., was elected a vice president of Cities Service Oil Company (Del.). He steps up to the vice presidency after 33 years with Cities Service in the fields of engineering and purchasing. He is manager of engineering and purchasing and coordinator between Bartlesville headquarters and the company's marketing division in Chicago. Bateman served for a year in Washington as director of materials for the Petroleum Administration for Defense and, on his return to Cities Service Oil Co. in 1953, was appointed manager of engineering and purchasing.

Lloyd A. Lynd was named financial vice president and chief financial officer of Cities Service and **G. R. Preston** elected to the board of that company and treasurer.

▸ **James C. Dangler** has joined Cooper-Bessemer Corporation as a sales engineer. In his new position, he will work under the supervision of **Fletcher M. Devin,** Cooper-Bessemer vice president and district sales manager of the East-Central sales district.

▸ **Carroll C. Cook** was named project manager in Delhi-Taylor Oil Corporation's special projects and planning department. He was formerly assistant to senior vice president **Fred P. Sewell.** Cook's duties are in the analysis and follow-up of new project proposals, reporting to **Dr. Elton Soltes,** director.

▸ **Joseph L. Seger,** president of the Carter division, Humble Oil & Refining Company, transferred to the parent Humble company as vice president for public affairs (public relations and government relations). **John W. Brice** resigned as an executive vice president of Humble to become president of the Carter division with headquarters in Tulsa, Oklahoma, and continues as a director of Humble.

Alan R. Martin Jr., was appointed assistant secretary of Humble Oil. He has been assistant secretary of Humble's Esso Standard division.

▸ **Bryce B. Reeve,** M.D., medical director of Standard Oil Company (Indiana), retired with more than 36 years' company service. **Gilbeart H. Collings Jr.,** M.D., is appointed medical director. He will spend the greater part of his time in coordinating the company-wide medical program. Dr. Collings has been associate director since last year, when he came to Standard from Crane Company.

Two other appointments in the medical department: **Paul D. Halley,** director of industrial hygiene, and **Marvin R. Alberg,** M.D., chief physician in charge of the general office medical department.

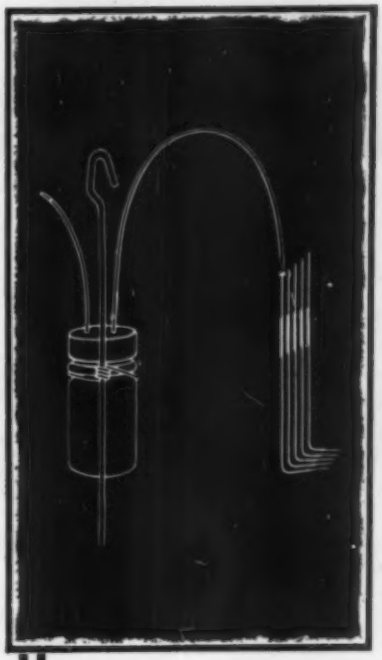
▸ **James M. Patterson,** director of public relations for American Oil Company, was elected chairman of the Advisory Committee on Public Relations of the American Petroleum Institute's Committee on Public Affairs. Elected vice chairman was **Don Sweeney,** manager of public relations for Socony Mobil Oil Company.

▸ **H. A. Dietrich,** vice president and manager of Burgess-Manning Co., industrial silencer division, has transferred to Dallas from Libertyville, Ill., former headquarters for the division. **A. P. Gallagher** was promoted from chief engineer to engineering coordinator in Dallas. He will be responsible for all engineering within the division. **Edmund J. Halter** recently joined the company as chief development engineer in charge of the division's research and development program. Promoted to the position of chief application engineer was **Bill Golden,** who is responsible for all field surveys and application recommendations. Golden joined the company in 1957 as an application engineer. **Carl Read Jr.,** the company's office manager in Dallas, has been appointed advertising manager.

R. J. McCormick, former coordinator of the company's Libertyville division, has been transferred to Dallas and promoted to senior sales coordinator. **P. J. O'Donnell,** division accountant, and **N. W. Tonchick,** chief draftsman, were also transferred to Dallas. The Libertyville district sales office will continue to be directed by **F. C. Duerr,** district manager, and **R. F. Anderson,** sales engineer.

Louis G. Halla was promoted from a sales engineer to manager of the

CANNON PENS



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Cannon Meter Pens are easily installed as original or replacement equipment in all standard recording instruments. Produce accurate charts of maximum legibility. No blurring or smearing.

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- Sealed ink supply prevents clogging from atmospheric contamination.
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- Available in five sizes and angles. Special pens designed to customer specifications on request.

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FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Here's the highballing crew that teamed up to pull and stack 6,000 feet of drill pipe in little more than one hour. Superintendent H. T. Love, and crewmen C. R. Williams, R. P. Williams and J. S. Light. Another member of the team—the International V-8 engine—is in the background.

6,000 feet pulled and stacked in 65 minutes with International V-8 engine

The Poole Well Service Co. of Midland, Texas is replacing 2½-inch tubing with 3½-inch for a sand fracturing operation on Humble's T & L lease. Sole power on their Wilson self-propelled servicing rig is an International UV-549 V-8 engine. With this dependable power the normal 4-man crew recently pulled and stacked 6,000 feet of 2⅞-inch drill stem in one hour and five minutes—an average of two stands per minute!

Your equipment, too, will perform more efficiently with smooth, dependable IH power. To adapt the engine to varying oil field requirements, there are fuel attachments for natural gas, combination natural gas and gasoline, and LPG; air compressor (engine mounted); hydraulic steering pump; Selectomatic torque converter or spring loaded clutch transmissions; exhaust condenser; top cylinder oiler; automatic safety shut-off; automatic radiator shutter; magneto ignition and gear driven mechanical governor. Your nearby International Engine Distributor or Dealer can give you product information and installation assistance on the complete line of 35 diesel and carbureted models—16.5 to 385 max. hp.

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A COMPLETE
POWER PACKAGE

Skinner Brothers' Report No. 2

Engineering Solves Line Surge Problem

New stabilizer installed on suction side of line reduces valve spring breakage by 80%

ALMOST ONCE every week it happened.

The valve springs on the water flood triplex pump broke. Operations came to a quick halt, and valuable time was lost until springs could be replaced.

The major oil company, operating the water flood system near El Dorado, Kansas, had had enough of this time-consuming, money-wasting problem.

Trouble Was Known. They knew what the trouble was.

The sudden surges of pressure in the suction line that fed into the pump would slap the pump mechanism with terrific peak force. The valve springs couldn't take it for more than a few days — then something *had* to give.

A new product, developed by Pulsation Engineering Company, was being tested in the field by Skinner Brothers Company.

It was a rugged new type of stabilizer, designed to absorb the fast, high-pressure surges of the suction line and relieve the pump of the continual stress reversal of the pressure surges.

"We'd like to see what this piece of equipment will do," the Skinner rep told oil company officials. "Let's install it and give it a test."

Five Weeks Later. It was five weeks after installation of the stabilizer that the next pump maintenance shutdown was required.

The stabilizer had reduced valve spring breakage by *80 per cent!*

Did it continue to work? Here's the answer: The El Dorado operation is now equipped with 10 suction-type stabilizers.

The essence of the new stabilizer is inside the tall steel casing, where a tough but super-pliable cartridge is housed.

This cartridge is big — offering 600 cubic inches of compressible gas volume — but its construction is the real secret of its success. It is built like a heavy-duty tire out of two layers of tension-tested nylon cord sheeted in a specially-compounded, Nitrile-based rubber that gives maximum flexibility, solvent resistance and durability.

The cartridge is molded and the metal caps vulcanized in a single operation to provide the tightest possible seal.

In both flow and suction side installations, the stabilizer is saving time and money for its users.

For test information, write to Skinner Brothers Company, Box 13556, Dallas, Texas.

---

the BIG ONE!

In Flow and Suction STABILIZERS

600 CU. INCHES OF COMPRESSIBLE GAS VOLUME

Here's the one stabilizer with the size and endurance to do the job and keep on doing it. The BIG ONE levels out the flow, evens up the pressure, gives your overtaxed pumps (*and* your pump budget) a break, on the suction or discharge side. Developed by Pulsation Engineering Co., available through supply stores everywhere, distributed by the expert nation-wide staff of

SKINNER BROTHERS COMPANY

Box 13556, Dallas • Box 628, Tulsa

Look into Lonergan Bellows Valves

Seven exclusive features reduce maintenance costs; provide increased valve versatility.

Like all bellows valves, Lonergan valves are designed to keep corrosive or viscous fluids away from working parts. In addition, they provide a balancing action against a variable back pressure. The similarity between Lonergan and any other bellows valve ends there. *Only Lonergan valves provide:*

1. *Saf-T-Alarm to warn of bellows failure. Alarm may be remotely located. (Optional at extra cost.)

2. Complete interchangeability with conventional valves of the same series.

3. Versatile cap arrangement. Bolted cap is standard and is interchangeable with a packed cap without taking the valve off the line or out of service. Gag facility is included.

4. *Simplified nozzle replacement due to an exclusive knockout feature. (Optional.)

5. A Hydro model; a patented, true, non-chattering liquid valve. Elimination of chatter ends bellows failure due to excessive flexing.

6. Reserve seating surface obtained from a built-in spare disc.

7. PVC trim, where pressure-temperature conditions permit.

These seven features mean economy for Lonergan valve users—in first cost; in operation; in maintenance. If your plant uses bellows valves, then it will pay you to investigate Lonergan. Series DB bellows valves are described in a new bulletin. Series D valves, available without the bellows, are also described. Write for your copy today.

**Patent Pending*

Lonergan

J. E. LONERGAN COMPANY, 205 RACE STREET
PHILADELPHIA 6, PENNA. • SINCE 1872

company's western district sales offices in Los Angeles.

Two men were promoted in the company's southern district sales office in Dallas. **H. L. Harris** is the new manager, and **G. R. Packer,** former sales coordinator, is now a sales engineer. **Albert J. Stella Jr.,** joined the company as a sales engineer in the eastern district sales offices in New York City.

DEATHS

▸ **Bruce Ramsey,** 65, retired former vice president and general manager and member of the board of directors of Interstate Oil Pipe Line Company, passed away suddenly April 27 in Wilcox, Arizona, of a heart attack.

▸ **Alexander E. Walker,** 72, retired chairman of the board of The National Supply Company, died in Pittsburgh, April 19, following an operation.

▸ **George W. Chapman,** 56, division manager of Sun Oil Company's Mid-Continent production division, died March 28 just as an emergency appendectomy was getting under way.

▸ **William B. Klaus,** 58, Tidewater Oil Company employee who was widely recognized as an authority on oil fire prevention and extinguishment, died April 10 in Los Angeles.

▸ **Percy H. Batten,** founder and chairman of the board of Twin Disc Clutch Company, died April 8 at Racine, Wisconsin, at the age of 86.

▸ **Ollie L. Turner,** 49, manager of the export division of Bowen Itco, Inc., Houston, died April 11, following a heart attack while in Coatzacoalcos, Ver., Mexico, on a business trip.

▸ **C. T. Shewell,** 57, a senior research specialist with Humble Oil & Refining, died of a heart attack April 7.

▸ **Herman W. Shubring,** gas transmission marketing consultant for Clark Bros. Co., division of Dresser Industries, Inc., died April 16 at the age 63.

▸ **Francis J. Curtis,** 65, retired vice president for personnel and former member of the board of directors of Monsanto Chemical Company, died April 21 of heart disease.

▸ **Harry Cain,** 60, assistant in the general office public relations department of United Gas, died March 26.

▸ **Carl Edward Haynes,** 50, engineer at Sterlington compressor station in United Gas Pipe Line Company's Monroe district, died March 14.

▸ **Charles T. Young,** 90, died April 2 after a prolonged illness. Before retiring he was factory manager at the Passaic plant of Raybestos-Manhattan, Inc.

▸ **Willis L. Lea Jr.,** vice president and general attorney for Southern Union Gas Company, died April 9 while on a fishing outing.

Laugh with Barney

A lot of enterprising young engineers are spending much of their valuable time tinkering with misses in their motors.

"My wife dreamed last night that she was married to a millionaire."

"You're lucky. My wife thinks that in the daytime."

One day a hillbilly cleaned his shotgun on the front porch. Next day his daughter had eight proposals.

Young woman to groceryman: "I would like a pint of oysters, please."

"Large or small?" asked the groceryman.

Faced with an unexpected decision, she thought a moment. "Well," she reasoned, "they're for a man with a size 15 collar."

"When trying to catch a husband, gals, play like a fisherman. Wiggle the bait once in a while."

They were seated on the veranda, the Kentuckian and the Englishman.

"This can't be beat," said the Kentuckian, "watching fine horse races and drinking good Kentucky bourbon."

"That's very jolly, I admit," said the Britisher, "but I'll take a good game of cricket and Scotch and soda, anytime."

About that time the waiter who had been serving them spoke up: "Did any of you gent'mens ever try women and watermelon?"

A young teacher was hired as a substitute for a friend who was taking a week off for a honeymoon. Later at a party, someone started to introduce her to the groom.

"Oh," he answered lightly, "I know Miss Jones very well indeed. She substituted for my wife on our honeymoon."

"When I was your age, young lady," said mother, "a nice girl didn't think of holding a man's hand."

"But mother," replied the daughter, "nowadays a nice girl HAS to hold a man's hand!"

Cannibal Chief: What did you do for a living?

Victim: I was an associate editor.

Cannibal Chief: Cheer up. Tonight you'll be editor-in-chief.

They say that love is blind, which may explain why some fellows like to feel around when out on a date.

Personnel Director, interviewing young curvy thing: "And now on this job you must be determined to show your ability, or bust . . .!"

"Grandpa, I notice that you've been reading Dr. Kinsey's book, 'The Sexual Behavior In the Human Female.' What do you think of it?"

"Wal, son. Part of it I already knowed. Part of it I kinda suspected. But the rest came too late."

Whatever I said in anger, whatever I shouted in spite, I'm sorry I spoke so quickly — I thought up some worse ones for tonight!

COUPLINGS BY Wheeling

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West Coast Factory: Woodlake, California

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You'll Never Go Wrong with FIELDMASTER BALL BEARING MOTORS

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- **VERMIN PROOF**
- **MOISTURE PROOF**
- **CORROSION RESISTANT**
- **FORCED AIR COOLED**
- **HAVE SEALED TERMINAL PORT**

SEMI-ENCLOSED — normal or medium slip, 3 phase, 60 cycle. Has prelubricated ball bearings in semi-enclosed protected housing, 40 degree C rise. Built for continuous duty. **High Torque, low starting** current. Extra insulating coating throughout.

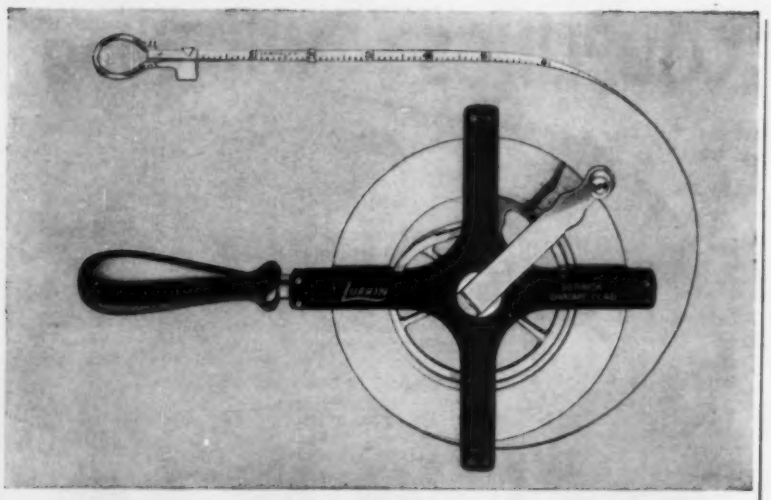
TOTALLY ENCLOSED — Fan cooled, normal or medium slip, 3 phase, 60 cycle. Has prelubricated ball bearings, totally enclosed FAN cooled 55 degrees C rise, for continuous duty. High Torque — low starting current. Extra insulating coating throughout.

Write for fully descriptive literature

BETHLEHEM STEEL CO. Supply Division **Tulsa, Oklahoma**

Manufactured by Valley Electric Corporation, St. Louis 8, Mo.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



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FROM SUMMER'S HEAT

Children Free. No charge for youngsters in room with parents. For folder, write Mgr., Hotel Galvez, Galveston Island, Texas.

HOTEL GALVEZ

Swimming Pool, Air-conditioned, Radio-TV, Fine Food

Word from Washington tells of a certain Senator who wanted to take a girl friend with him on a trip to Chicago.

"I have senatorial immunity," he assured her. "So you needn't be afraid of the Mann Act."

"Afraid of it?" she giggled. "Why, Senator, I just adore it."

' ' '

The girl I left behind me
I think of night and day,
For if she ever finds me
There'll sure be hell to pay.

' ' '

With his girl at his side, the sailor watched from the pier as his ship majestically steamed away through the Golden Gate. Finally he turned to the girl and said: "Now, we're both in trouble."

' ' '

Two men were weaving their way homeward after a late and liquid stag party. "Gosh," said one, "My wife will hit the ceiling when I get home. Will yours?"

"Yep," hiccupped the other. "She's a terrible shot."

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Technical service and sales work for sanitary or petroleum engineer with experience in water flooding. Salary and commission. *Write fully, including recent photograph, to* **Buckman Laboratories, Inc., 1256 North McLean Street, Memphis 8, Tenn.**

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Eight over-stocked new Gardner-Denver compressors for sale 30 per cent off new price.

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Trainee for leading oil, gas, petro/chem publications. Must be personable, intelligent, tactfully aggressive. He could be a graduate in advertising, marketing, journalism, or a petroleum, mechanical or chemical engineer presently employed in the oil-gas industry. Writing aptitude important. Excellent opportunity for young man of right qualifications. *Apply by letter and resume to* **P. O. Box 1589, Dallas, Texas,** *sending qualifications, telephone number and photo. Replies will be held in confidence.*

OVERSTOCKED!

Large quantity overstocked new Darling pipe line valves selling at 50 per cent off list, also selling large quantity of other valves at greatly reduced prices. Your inquiry will be appreciated.

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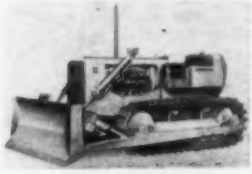
WHY GEORGE PEASE USES

D6s for SITE PREPARATION

THIS is one of 60 sites recently prepared by George W. Pease for a large oil company. The location: Osage County, Oklahoma. The job at each site: leveling an area about 85 feet x 130 feet for drilling rig and equipment and digging a slush pit 70 feet square and 5 feet deep. Depending on conditions, it took the Cat D6 Tractor with No. 6S Bulldozer from one to three days to prepare a site.

Why did George Pease choose the D6? An important reason, he'll tell you—"It stands up better than competitive machines." His is no snap judgment, for he's a veteran with 16 years' experience in the business. Ask others like him, who make their living in the same kind of tough work, and you'll hear the same verdict on the D6.



NOW THE NEW D6 SERIES B

Stacked against the previous model—or against any tractor of comparable size—the new D6B is even further out front from every angle: greater production, low-cost operation and time-saving maintenance. Some reasons why:

NEW ENGINE—A Cat D333 Diesel Engine (93 flywheel HP) delivers 25% more lugging ability. New direct-acting governor for quick fuel adjustments handles loads faster.

NEW INTEGRAL HYDRAULIC SYSTEM—Under-the-hood mounting of tank, pump and valves permits convenient routing of hydraulic lines to bulldozer or implement cylinders, frees front and rear for other equipment.

NEW OPERATOR CONVENIENCE—An all-new cockpit has coordinated controls that make the tractor operate almost as if it knew what was needed next.

NEW 8-FOOT BULLDOZER BLADE—This shorter straight blade combines productive capacity with narrow width. No highway permit is required to move machine from job to job.

And that's not all. The new D6B also features dry-type air cleaner, hydraulic track adjusters (optional), lifetime lubricated track rollers, the oil clutch and forward-reverse lever. Get the full details from your Caterpillar Dealer. Ask him to *show* you how the new D6 can step up production on your job!

Caterpillar Tractor Co., General Offices, Peoria, Illinois, U.S.A.

CATERPILLAR

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MODERN
HEAVY-DUTY MACHINES
FOR THE HARD WORK

Books To Read . . .

Chemical Technology of Petroleum, *by William A. Gruse and Donald R. Stevens. Published by McGraw-Hill Book Company, 327 W. 41st Street, New York 36, New York. Pages, 800. Price, $15.*

New third edition covers the chemistry of petroleum and the modern methods, standards, and practices of petroleum distilling and refining. The authors explain recent applications of thermodynamics in solving problems of hydrocarbon chemistry and the production and uses of derived by-products.

Thermal cracking, solvent separation, chemical conversion by catalytic methods, and chemical synthesis of products are discussed thoroughly. The book also presents an overall, factual picture of the industry in America.

Characteristics of Engineers and Scientists *by Lee E. Danielson. Published by Bureau of Industrial Relations, University of Michigan, Ann Arbor, Michigan. Pages 136. Price, $4.*

This is the fourth in a series of reports which deal with business managers' relations with the engineers and scientists in their employ. The reports are based on an investigation the major purpose of which is to identify and publicize managerial policies and practices that promote the productivity of these professionals and increase their satisfaction in their work.

The study on which this report is based was conducted by the Bureau of Industrial Relations at The University of Michigan. Ten well-established, well-managed companies, each with a sizable technical staff, cooperated by allowing Bureau representatives to interview engineers and scientists in their employ.

In each company, executives and recruiting and personnel officers were interviewed in order to gain the broad company perspective and general policies.

One interesting list included in the volume is a pattern of work habits for the ideal professional employee:

a. willingly accept assignments and assume responsibility for their completion,
b. overtly express his interest and enthusiasm,
c. start immediately on assigned projects and on occasion initiate projects within his area,
d. analyze the problems from the company's standpoint,
e. thoroughly organize his own work and that of his subordinates,
f. demonstrate his creativity and originality at the same time as exercising sound judgment,
g. sustain his productivity throughout the life of the project without supervisory prodding or excessive direction,
h. rapidly complete his assignments while maintaining high quality standards,
i. clearly and dependably report his findings in both oral and written form.

Throughout these chapters and especially in the "Summary and Recommendations," the author interprets the feelings expressed and suggests courses of action to be taken in gaining maximum utilization and satisfaction. Specific recommendations are made for higher management, first-line supervisors of professionals, presently employed and future engineers and scientists, and colleges and universities.

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Meetings . . .

June 25-29 — **Petroleum Equipment Suppliers Assn.**, silver anniversary meeting, Banff Springs Hotel, Banff, Alta.

July 28-30 — **API Division of Production**, eastern district meeting, Greenbrier Hotel, White Sulphur Springs, W. Va.

Aug. 15-17 — **American Society of Mechanical Engineers — American Institute of Chemical Engineers**, heat transfer conference and exhibit, Statler Hilton Hotel, Buffalo, N. Y.

Aug. 29-31 — **20th Annual Appalachian Gas Measurement Short Course**, West Virginia University, Morgantown, West Virginia.

Sept. 11-16 — **American Chemical Society**, national meeting, New York City.

Sept. 14-16 — **National Petroleum Assn.**, annual meeting, Traymore Hotel, Atlantic City, N. J.

Sept. 15 — **Natural Gasoline Assn. of America**, Rocky Mountain regional meeting, Palliser Hotel, Calgary, Alberta, Canada.

Sept. 18-21 — **American Society of Mechanical Engineers**, petroleum mechanical engineering conference, Jung Hotel, New Orleans, La.

Sept. 19-21 — **Texas Mid-Continent Oil & Gas Assn.** annual meeting, Hilton Hotel, San Antonio, Tex.

Sept. 25-27 — **American Assn. of Oilwell Drilling Contractors**, annual meeting, Roosevelt Hotel, New Orleans, La.

Sept. 25-28 — **American Institute of Electrical Engineers**, petroleum industry committee, Hotel Skirvin, Oklahoma City, Okla.

Sept. 29-30 — **Mid-Continent Oil & Gas Assn.**, Mississippi-Alabama division meeting, Grand Hotel, Point Clear, Ala.

Oct. 2-5 — **Society of Petroleum Engineers of AIME**, annual fall meeting, Denver, Colo.

Oct. 6-7 — **National Assn. of Corrosion Engineers**, annual Western region conference, Sheraton-Place Hotel, San Francisco, Calif.

Oct. 6-8 — **National Assn. of Corrosion Engineers**, Southeast region conference, Dinkler-Plaza Hotel, Atlanta, Ga.

Oct. 10-12 — **American Gas Assn.**, annual convention, Atlantic City, N. J.

Oct. 11-14 — **National Assn. of Corrosion Engineers**, Northeast region conference, Prichard Hotel, Huntington, W. Va.

Oct. 12-14 — **Southwest Federation of Geological Societies**, annual meeting, Abilene, Tex.

Oct. 13-14 — **California Natural Gasoline Assn.**, annual fall meeting, Hotel Miramar, Santa Monica, Calif.

Oct. 19-20 — **National Assn. of Corrosion Engineers**, North Central region conference, Schroeder Hotel, Milwaukee, Wis.

Oct. 19-21 — **Rocky Mountain Oil and Gas Assn.**, annual convention, Brown Palace Hotel, Denver, Colo.

Oct. 20-21 — **Society of Petroleum Engineers of AIME**, Los Angeles Basin section, fall meeting, Huntington-Sheraton Hotel, Pasadena, Calif.

Oct. 23-25 — **Independent Petroleum Assn. of America**, annual meeting, Statler-Hilton Hotel, Dallas, Tex.

Oct. 25-28 — **National Assn. of Corrosion Engineers**, South Central region conference, Mayo Hotel, Tulsa, Okla.

Oct. 28 — **Natural Gasoline Assn. of America**, Southern regional meeting, Palliser Hotel, Calgary, Alberta, Canada.

Oct. 31-Nov. 1 — **National Lubricating Grease Institute**, annual meeting, Edgewater Beach Hotel, Chicago, Ill.

Nov. 3-4 — **Society of Automotive Engineers**, national fuels and lubricants, Mayo Hotel, Tulsa, Okla.

Nov. 14-16 — **American Petroleum Institute**, annual meeting, Conrad Hilton, Palmer House and Congress hotels, Chicago, Ill.

Nov. 18 — **Natural Gasoline Assn. of America**, Panhandle Plains regional meeting, Herring Hotel, Amarillo, Tex.

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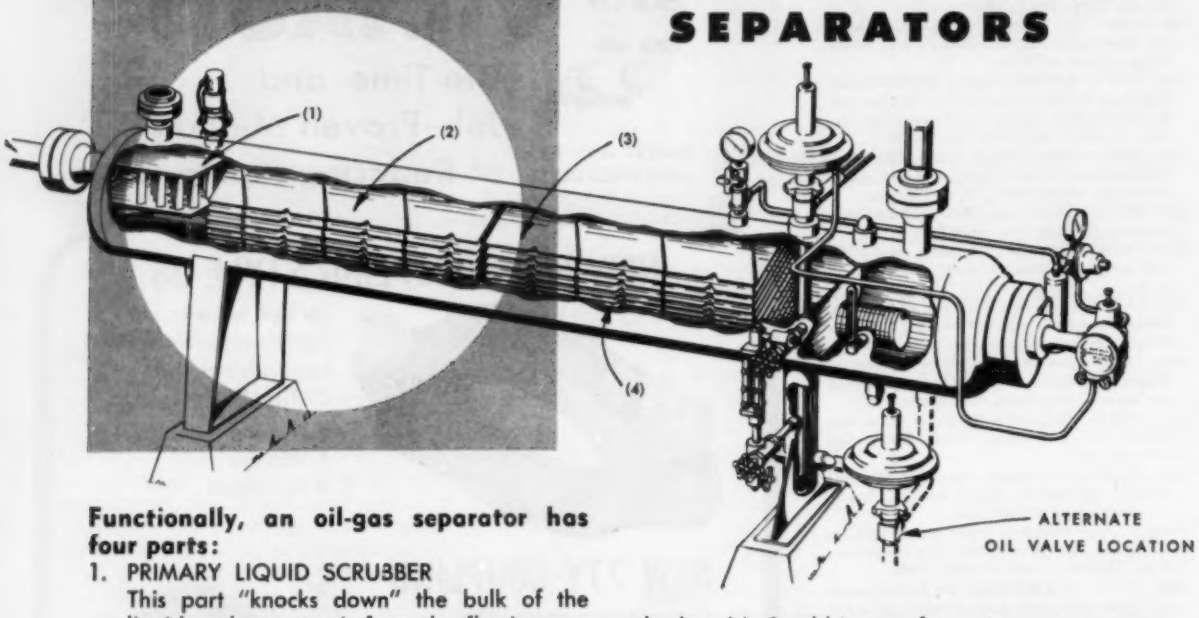
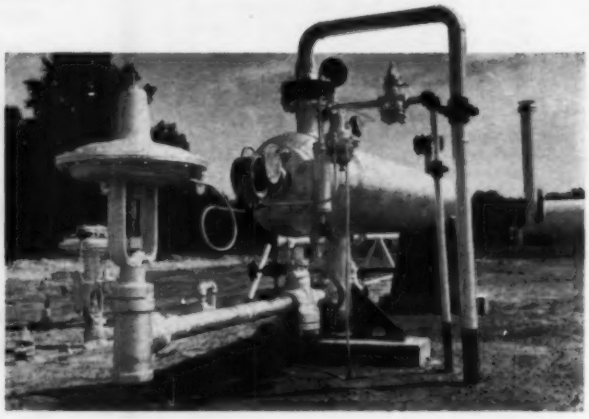
NATIONAL® MONOTUBE® SEPARATORS



Functionally, an oil-gas separator has four parts:

1. PRIMARY LIQUID SCRUBBER
   This part "knocks down" the bulk of the liquid and removes it from the flowing gas stream immediately.
   National's present design is the result of field tests using full scale operational models which utilized numerous scrubbing elements. From these tests National's present design was found. Today, when you buy a National MONOTUBE Separator, you buy experience, not experimentation.
2. MAIN GAS SCRUBBER
   Also as a result of these tests, proper spacing and length of Main Gas Scrubber plates was discovered, so as to effect the greatest liquid removal from the gas stream.
3. FINAL GAS SCRUBBING
   The multiple field tests with flanged components dictated our design. National's "straight-vane" design accomplishes final liquid removal without the use of "excelsior-like" elements which are prone to be plugged with waxes, sands and other extraneous materials, including hydrates inherent in the normal oil-gas and distillate production operations.
4. OIL DE-GASSING COMPARTMENT
   What effects oil de-gassing? (a) Length of time in compartment. (b) Surface area of oil body. (c) Scrubbing surfaces to remove entrained gases. When (a), (b) and (c) are at a maximum, oil de-gassing is best. National's full-scale field testing found the proper ratios.



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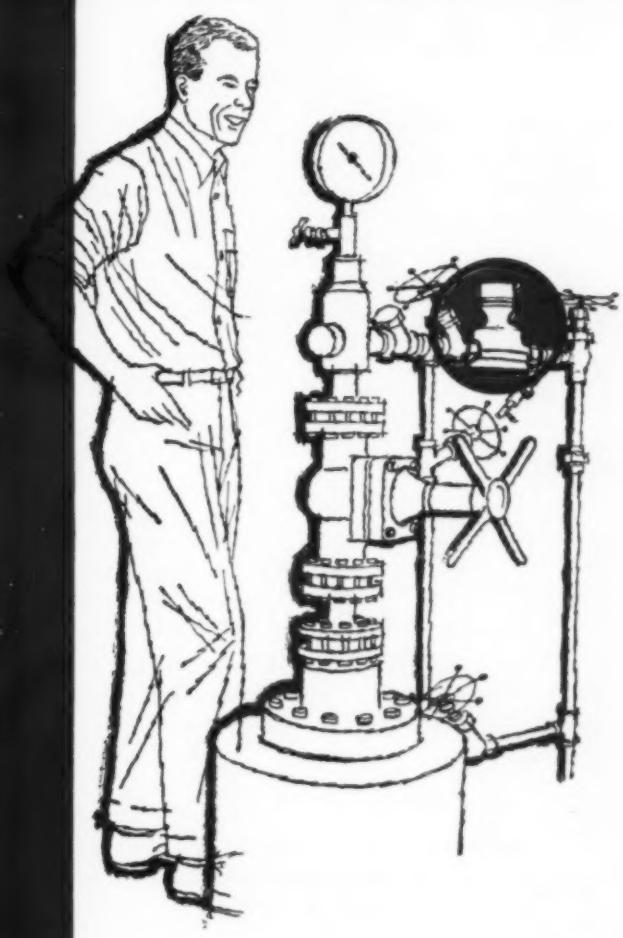
TULSA, OKLAHOMA

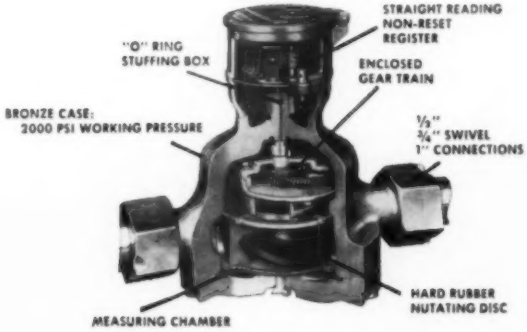
Safe, Sure Water Flooding with



ROCKWELL "504" FIVE POINTER METERS

Water flooding pressures are going higher! To meet this challenge you need meters that will measure accurately, without leaks or failures, at operating pressures of up to 2000 psi. In short, you need Rockwell "504" Five Pointer meters which are designed and tested to meet this higher working pressure requirement.

Rugged reliability is built into this sturdy meter plus options designed to best handle your service needs. For example you can have *either* bronze or nickel alloy construction in measuring chambers. Optional coupling sizes of ½", ¾" or 1" simplify installation. For complete details and specifications, write for bulletin OG-353 to Rockwell Manufacturing Company, Pittsburgh 8, Pa. In Canada: Rockwell Manufacturing Company of Canada, Ltd., Guelph, Ontario.

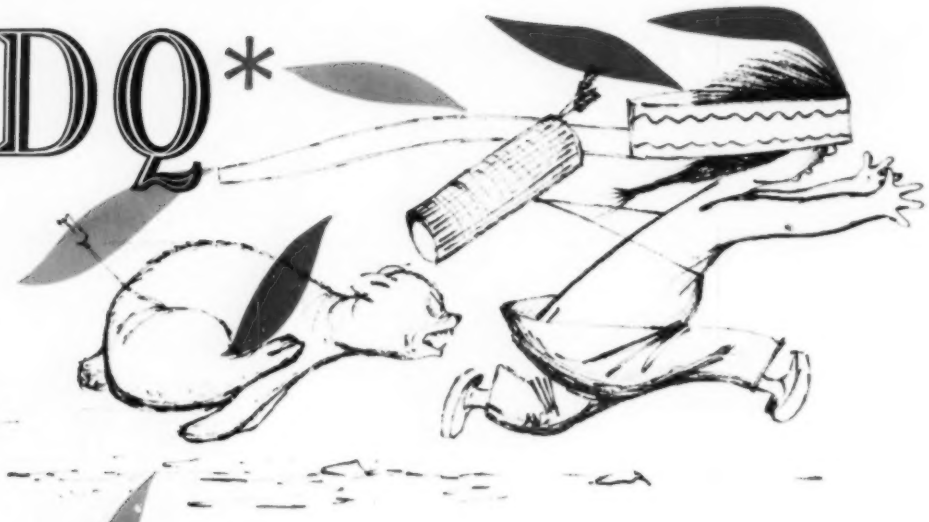

STRAIGHT READING NON-RESET REGISTER
"O" RING STUFFING BOX
ENCLOSED GEAR TRAIN
BRONZE CASE: 2000 PSI WORKING PRESSURE
½" ¾" SWIVEL 1" CONNECTIONS
HARD RUBBER NUTATING DISC
MEASURING CHAMBER

WATER FLOODING METERS

another fine product by

ROCKWELL

PDQ*



Pretty dern quick!

That's the kind of service you want. And when you choose Welex to complete your well, that's the kind of service you get. Like the papoose above, our crews hit the ground "a runnin" and wrap up the job in a minimum of time.

But to Welex, PDQ means more than speedy service. Here's the difference that makes Welex well completion services outstanding:

*P — Penetration

Penetration means Welex jet perforating. This is the most important factor in successfully completing a well. Whether you choose the 5-inch Super Dyna-Jet[1] for standard completions or the power-packed Sidewinder[1] for a 2-inch tubingless completion or one of the many other types and sizes of jet guns, you get deepest penetration. Welex's continuous laboratory and field testing and research guarantee you deeper penetration every time with the maximum flow index.

*D — Developments

New developments from Welex's research facilities have a way of soon becoming standards of the industry. Just as the Swing-Jet[1] and Link-Jet[1] opened new horizons in throughtubing completions, new tools presently in development stages soon will be introduced in the field. These will mark another first by Welex in offering the finest proven well completion tools.

*Q — Quality

Quality is Welex. Quality well completion services from Welex assure you that your well is in good hands. Welex equipment, developed by the industry's finest research facilities, and Welex engineers, backed by years of experience, form a combination that can turn a million dollar gamble into a sure winner. Why settle for less than the best? That's Welex, the company that originated jet perforating —the company that offers a complete selection of well completion services for every type of well.

Next time and every time call your Welex representative for top completion services "PDQ."

WELEX, INC.

General Offices: 1400 East Berry, Fort Worth, Texas
In Canada: Welex of Canada, Ltd.
[1]*Trade Marks of Jet Research Center, Inc.*

Of Things To Come . . . In Oil

EAST COAST OFFSHORE TESTS, now numbering more than 200, have found no oil, but scientists James Trumbull and John E. Johnston of the U. S. Geological Survey believe there may be plenty of oil along this 1100-mile continental shelf area. A recent joint meeting of the American Association of Petroleum Geologists and the Society of Economic Paleontologists and Mineralogists focused attention on two long troughs paralleling the edge of the continental shelf. The inner trough contains up to 18,000 ft of potential oil producing sedimentary rocks, while the outer one contains more than 25,000 ft of such rocks in some places.

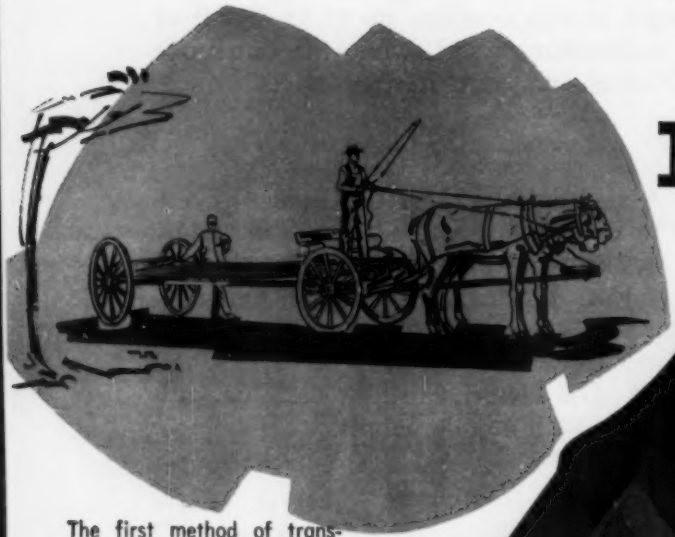
PROPOSED WATERFLOOD OF ANETH FIELD of the Four Corners area will be the project of an engineering committee established by the operators. Initial surveys show advantages of an early start in the secondary recovery project. Arrangements are still tentative, but 80-acre producing tracts will be included in the participating area, with participating interests to be based on Desert Creek and Ismay pay zones in acre-ft. The Desert Creek is credited with 712,000 acre-ft and the Ismay with 45,000 acre-ft.

LOOK FOR MORE IMMEDIATE HELP from the research laboratories on your day-to-day drilling and production problems. The practical approach is joining pure "blue-sky" research in most of the industry's laboratories, and this will result in reducing the time between first consideration of a problem to field application of a solution.

TWO UNDERGROUND CHEMICAL EXPLOSIONS in Colorado oil shale fields have been scheduled for June by the Atomic Energy Commission. Radioactive gas tracers will be used in the experiments, but the explosions will not be nuclear. AEC is staging tests to evaluate possible effects of future underground nuclear blasts. Canada has postponed proposed Athabasca tar sands explosions for at least two years due to country's reluctance to set off nuclear explosions of any kind and to disagreement on safety of project.

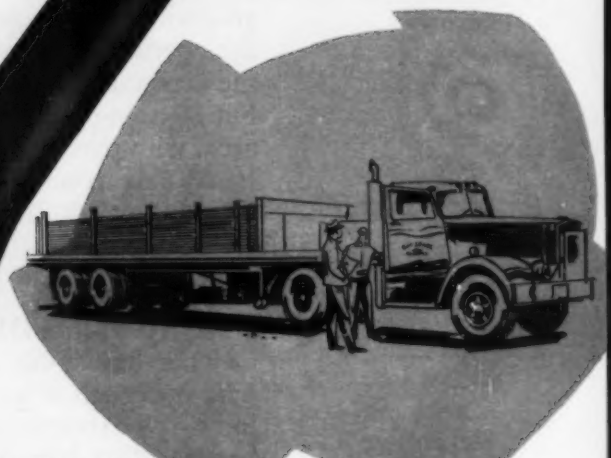
JONES

FIRST IN 1894...



The first method of transporting Jones all-metal sucker rods left something to be desired. Not much support for those rods between the wagon axles...

FIRST TODAY...



Now, Jones Sucker Rods receive the greatest care in handling and shipping...rail or truck...so that they arrive with factory perfection. Another service you can expect from **Sucker Rod Specialists!**

...because we're Sucker Rod Specialists!

There are four JONES JOB-ENGINEERED SUCKER RODS... a type for every pumping need!

THE S. M. JONES COMPANY

Division of Buffalo Eclipse Corporation

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Western Conducts More Marine Seismic Surveys Than All Other Contractors Combined!

Every year since 1954, Western Geophysical Company boats have done well over half of ALL contract offshore seismic explorations in the world.

This record reflects the considered judgment of many of the most respected people in the petroleum industry on the competence of Western men, techniques and instrumentation. When you consider your next geophysical survey, let us tell you more about the Western services that have earned and held such confidence.

Additionally, Western's land seismic parties and gravity crews are at work on four continents.

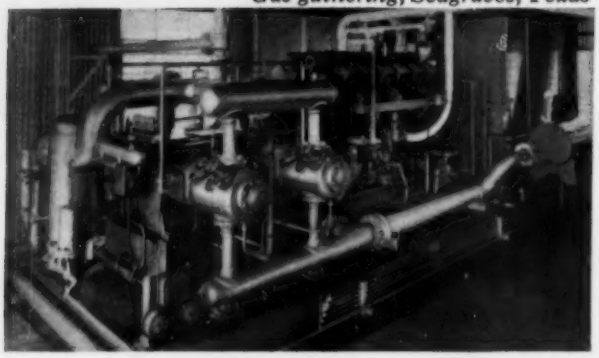
Western

GEOPHYSICAL COMPANY
AND ITS AFFILIATES

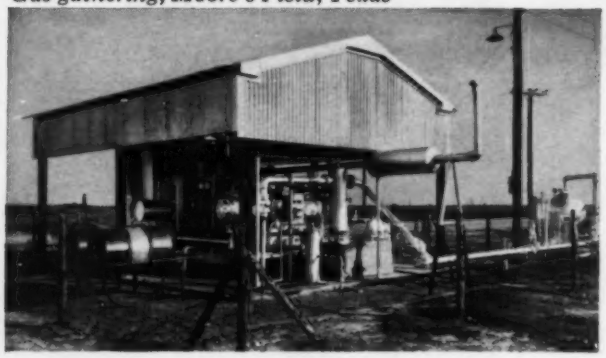
Principal Office: 523 WEST SIXTH STREET · LOS ANGELES 14, CALIFORNIA

AFFILIATE AND REGIONAL OFFICES THROUGHOUT THE WORLD

Gas gathering, Seagraves, Texas



Gas gathering, Moore's Field, Texas

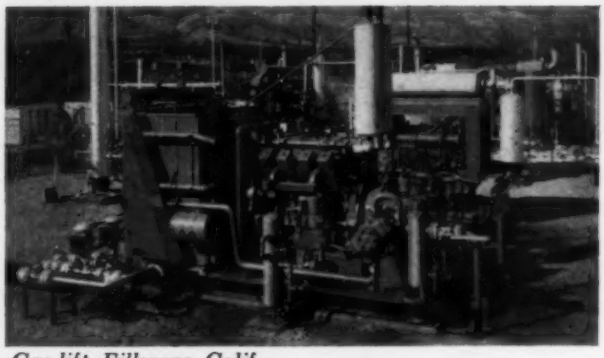


AGAIN and AGAIN...

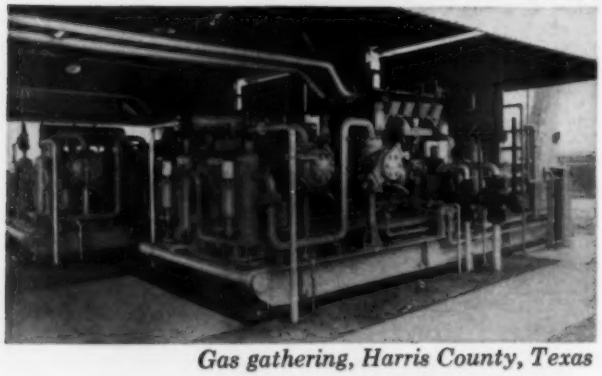
Gas gathering, Barataria, La.

Gas gathering, Clarkwood, Texas

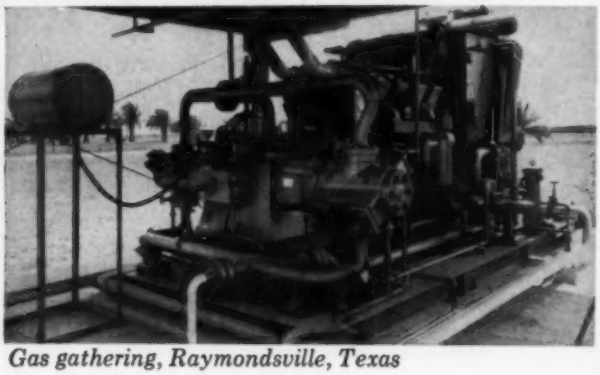
Gas gathering, Tivoli, Texas



Gas lift, Fillmore, Calif.



Gas gathering, Harris County, Texas



Gas gathering, Raymondsville, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

OPERATORS CHOOSE
CLARK CFA and CFB COMPRESSORS

Because the Clark CFA and the larger CFB packaged compressors are specifically engineered for rugged field service year after year . . . an increasing number of operators are finding them versatile and highly dependable units for gas gathering, gas boosting and other field services. Here are some of the outstanding reasons for this growing preference:

Both the CFA and the CFB are built around the Clark Balanced/Opposed design. With all unbalanced forces cancelled out, these compressors can operate at a modern 1000 rpm. Perfect balance also eliminates the need for large conventional foundations. A thin slab of concrete to level the unit—or even a trailer—is ample. Direct coupling to API-rated engines makes belt and gear drives unnecessary. Operators who use these Clark compressors invariably order more.

There are 15 sizes to choose from in the 100 to 350 bhp range. For full information, contact your nearest Clark representative and ask for CFA Bulletin No. 158 or CFB Bulletin No. 171. Or write to Clark Bros. Co., 1031 Lincoln Ave., Olean, N. Y.

Clark Model CFB-2, 350 bhp, two-stage packaged field compressor

CLARK

CLARK BROS. CO.

One of the Dresser Industries

COMPRESSORS • ENGINES • GAS TURBINES

Macks are the muscles of the oil fields. Here one of Bill Hodges' B-61 Model Macks places heavy machinery at drill site. Rutted, muddy footing is taken in stride because Mack oil field trucks are built for oil field work.

MACK
for over 7 straight years
NO.1
by far in sales of diesel trucks

Oil field trucker Bill Hodges says

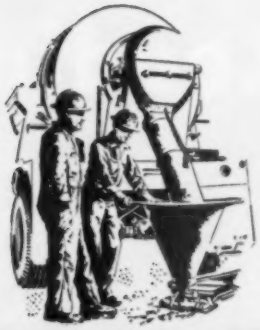
"We use the best equipment we can buy"

"It doesn't pay to fool around with 'bargain' equipment in the oil fields," says Bill Hodges, head man at the Oklahoma City trucking company that bears his name. "Hundreds of rig moves have taught us the value of quality equipment. From trucks on down, every piece of equipment we use is one grade – the best."

Bill Hodges Truck Co. operates dozens of Macks . . . has units to handle loads up to 160,000 lbs. Macks have the capacity, the power, the rugged strength and flexibility to deliver rigs, equipment and machinery where they're wanted, when they're wanted. Mack-built Thermodyne® engines – gasoline or diesel – are unexcelled for long life, dependability and fuel economy. Mack-built transmissions are available up to 20 speeds, and are built to accommodate power takeoff units. On 6-wheel units, Mack's Balanced Bogie with Power Divider allows Mack trucks to move the heaviest loads over the roughest oil-field terrain by automatically applying controlled torque to the axle with greater traction.

In oil field work where more is demanded of a truck, you'll get more out of a Mack. Your Mack branch or distributor will be glad to show you why. Mack Trucks, Inc., Plainfield, New Jersey. Mack Trucks of Canada, Ltd., Toronto, Ontario. 7714

MACK
FIRST NAME FOR
TRUCKS



DIACEL BRIEFS

CEMENTING DATA — REPORT 60-2

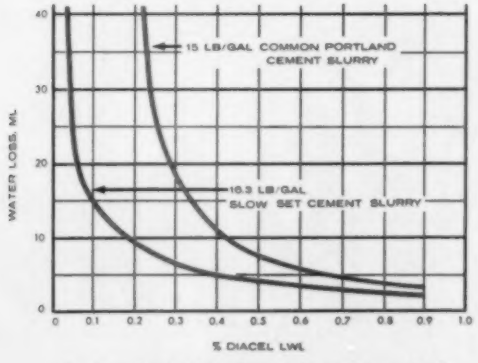
Better SQUEEZE JOBS Made Possible With Diacel* LWL—Low Water Loss Cement Additive

Cements with controlled water loss and thickening time are ideal for casing cementing. They are even more ideally suited for squeeze cementing. The success ratio of squeeze cement jobs has increased greatly with the use of Diacel LWL Cement Systems. These systems can be formulated from 10.3 to above 20.0 lbs./gal. and tailored to meet practically all thickening time requirements.

High Pressure Squeeze Cementing

Many times a high filtration or high water loss cement is dehydrated and left inside the casing opposite perforations and requires drilling out. Use of a Diacel LWL Low Water Loss Cement System in a high pressure squeeze job minimizes dehydration of the slurry to permit the entire perforated interval to be covered with cement. Such a Diacel LWL slurry can be washed or reversed out after the desired squeeze pressure has been reached, which eliminates the drilling of the cement from the casing. This permits other operations in the well, such as, perforating, drill stem testing and resqueezing without pulling the packer. The mechanics of the job are basically the same as those used on conventional squeeze jobs, except the initial pumping rates may be reduced. Hesitation pumping may be necessary to obtain desired squeeze pressures.

The following example of this improved squeeze technique took place in a field where zones require several squeeze jobs for successful completions.



As shown in the chart above, only small amounts of Diacel LWL are required to reduce water loss below 10 ml.

Problem: *A string of 5½" casing equipped with centralizers and reciprocating scratchers was stuck at 7507 feet, approximately 2500 feet off bottom. A 4½" liner was set with partial returns to total depth with top of liner at 7418 feet.*

The first attempt to obtain an effective seal was a 3-stage cement job requiring 550 sacks of slow-set cement placed on top of the liner. The well was perforated at 9113-20 feet and on test produced 1101 barrels of salt water with no oil at flowing top pressure of 2300 psi. Perforations were squeezed with 200 sacks of slow-set cement with a 2000 psi build-up. Cement was left opposite the perforations. After drilling the cement plug, the formation took fluid at 2200 psi.

Solution: To prevent another unsuccessful squeeze job, 225 sacks of Portland cement were mixed with 0.3 per cent Diacel LWL and 3 per cent Diacel A Accelerator. The desired surface squeeze pressure of 5000 psi was obtained when 200 sacks of this slurry had been pumped into the formation. After drilling out cement, the well was perforated at the original interval of 9113-20 feet. The well produced 182 barrels distillate and 1900 MCF gas with flowing top pressure of 3052 psi . . . the result of a most successful squeeze job.

Summary of Advantages

Diacel LWL controls fluid loss and retards thickening time of slurries. It permits safe placement in deep high temperature wells and has proved successful in wells with bottom hole temperatures above 400°F. These low water loss slurries protect against pipe sticking, flash setting and pay zone water damage while cementing. Also, the chance of channeling and circulation troubles are minimized.

More complete data and information on Diacel Cement Systems may be obtained from your Drilling Specialties Company field engineers, your cement service company, or by writing . . .

*A trademark

DRILLING SPECIALTIES COMPANY
Bartlesville, Oklahoma

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Two experienced producers get their heads together. Research and progress are reflected in Cabot performance. More and more leading producers use these units because of Cabot's dependability. Cabot units are available with API gear box ratings of 6,400 to 456,000 inch-pounds. Cabot offers a complete line of beam balanced, crank balanced and air balanced units.

How Leading

Production Men Cut Costs

Leading production men select quality equipment for long life and low maintenance. They rightly reason that extra performance and dependable service add up to real economy.

Time proven, blue chip equipment sold by J&L Supply yields dividends for production men who use performance as a yardstick for measuring costs.

Your J&L man has up-to-date literature for your reference on our complete line of quality production equipment.

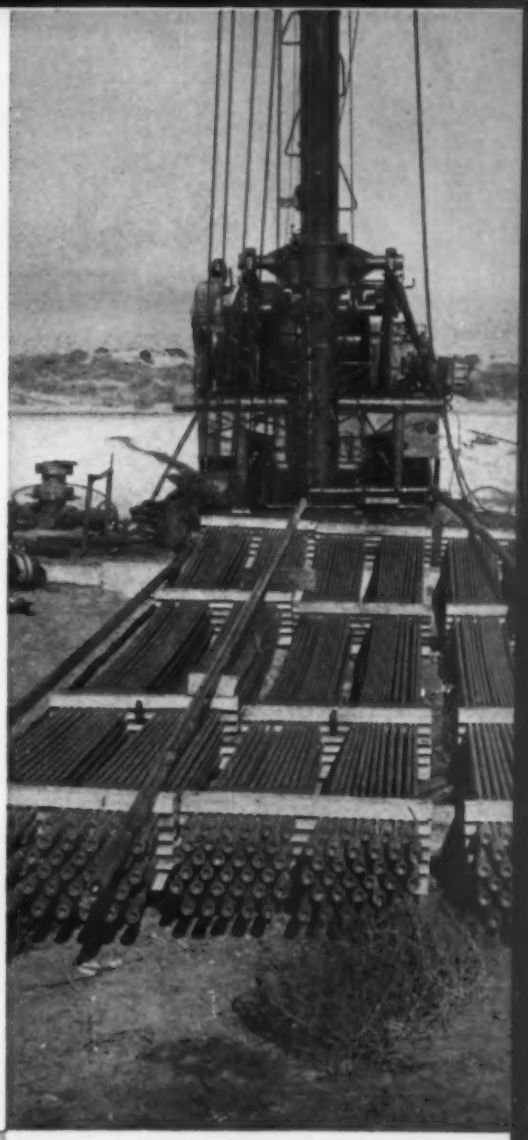
Invest in quality — and save. Call your J&L Supply man today.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

If it's sold by J&L....
It's the best available

109



Axelson gives you dependable rod strings and bottom hole pumps designed for varied depths and working conditions. Axelson pumps are tailor-made for problem production such as stripper wells, high volume requirements, sand conditions or corrosive agents. J&L pump shops back up Axelson quality with fast dependable service.

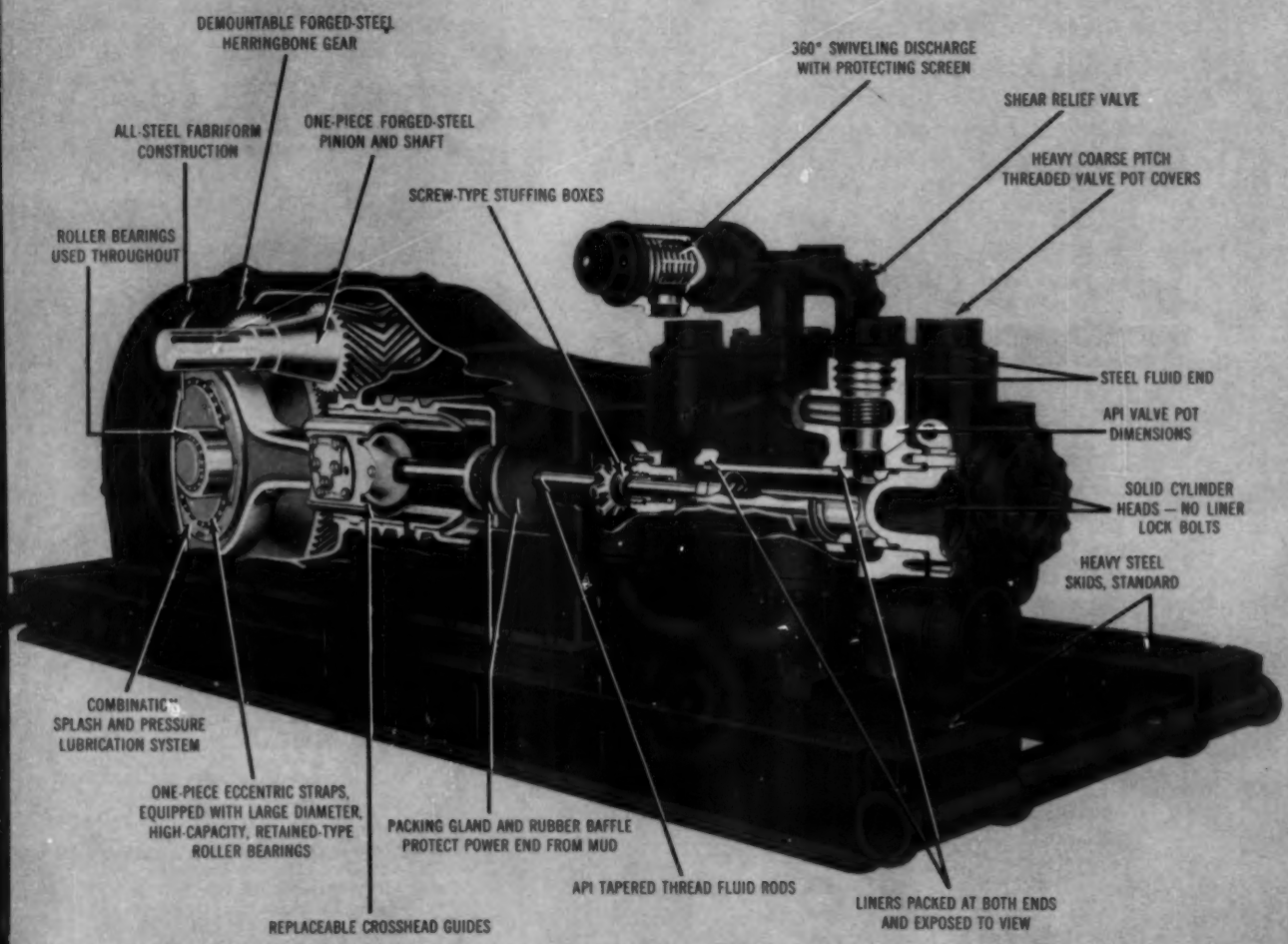
A complete line of Jones & Laughlin casing and tubing is available for your production requirements. Special designs are available in addition to regular API products. J&L Extreme Line* casing, Buttress Thread casing and Grayloc tubing are good examples of our special purpose products. Literature on J&L tubular goods is available today from your local J&L man.

*Manufactured under license from The National Supply Co.

NOW 7 CONTINENTAL-EMSCO SLUSH PUMP SIZES

..a complete line able to provide all the mud pressures and volumes needed for today's drilling rigs

Feature by Feature..you can't beat these Pumps

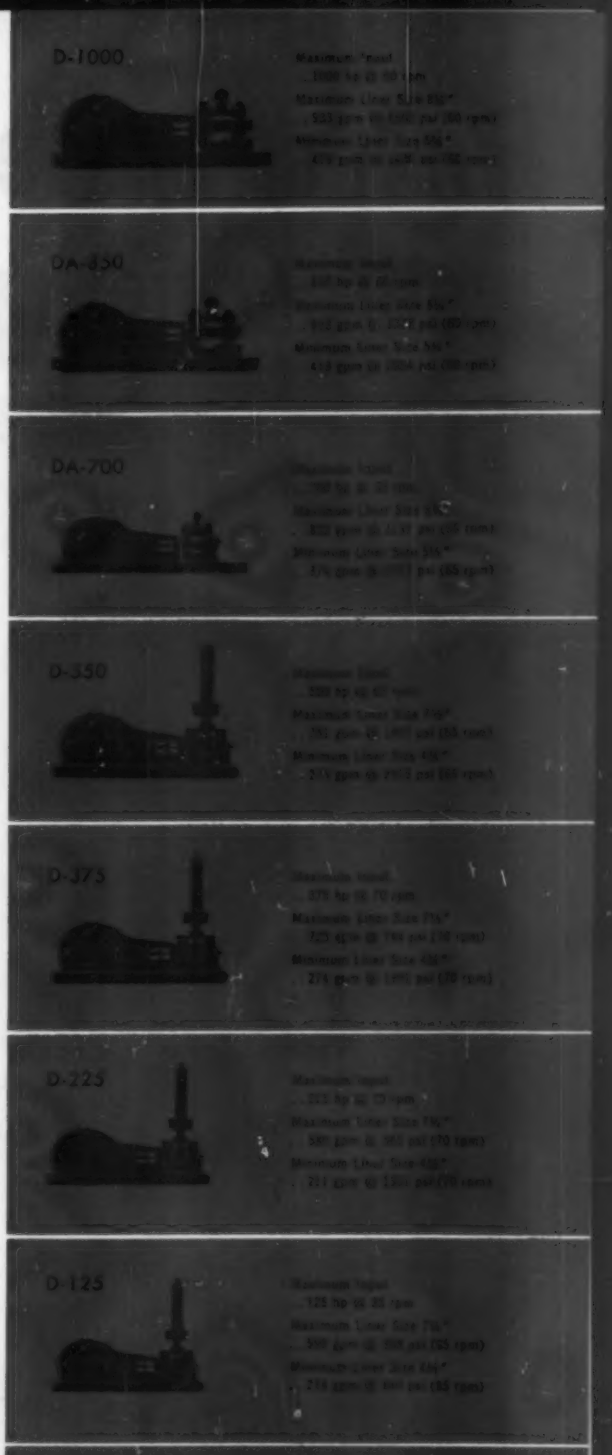

DEMOUNTABLE FORGED-STEEL HERRINGBONE GEAR
ALL-STEEL FABRIFORM CONSTRUCTION
ONE-PIECE FORGED-STEEL PINION AND SHAFT
ROLLER BEARINGS USED THROUGHOUT
SCREW-TYPE STUFFING BOXES
360° SWIVELING DISCHARGE WITH PROTECTING SCREEN
SHEAR RELIEF VALVE
HEAVY COARSE PITCH THREADED VALVE POT COVERS
STEEL FLUID END
API VALVE POT DIMENSIONS
SOLID CYLINDER HEADS — NO LINER LOCK BOLTS
HEAVY STEEL SKIDS, STANDARD
COMBINATION SPLASH AND PRESSURE LUBRICATION SYSTEM
ONE-PIECE ECCENTRIC STRAPS, EQUIPPED WITH LARGE DIAMETER, HIGH-CAPACITY, RETAINED-TYPE ROLLER BEARINGS
PACKING GLAND AND RUBBER BAFFLE PROTECT POWER END FROM MUD
API TAPERED THREAD FLUID RODS
LINERS PACKED AT BOTH ENDS AND EXPOSED TO VIEW
REPLACEABLE CROSSHEAD GUIDES

POWER END DESIGN

In place of bulky steel castings, a smooth, easy to handle steel fabriform frame is used. Fabriform construction allows critical stress areas to be reinforced scientifically, and it is as strong, yet lighter than castings. The massive main gear, of wear-resisting heat-treated forged steel, is designed to handle the highest of mud pressures. It is matched with a long-wearing, heat-treated forged-steel pinion, machined integrally with its shaft. Roller bearings, used throughout, reduce power loads and eliminate need for bearing adjustment. Crosshead guides (slippers in larger pumps) can be replaced for added years of pumping.

FLUID END DESIGN

Steel castings are electrically welded into compact fluid ends to handle the highest of mud pressures. Suction passages are large, direct and smoothly curved to speed fluid flow, even when pumping heavy muds. Use of one suction eliminates *dead spaces* which tend to restrict flow. A separate pot for each valve provides easy access to valve chambers. Screw-type valve-pot covers speed valve replacement. Patented "exposed" liner construction prevents costly washouts and damage to liner or fluid ends, because leaks can be spotted and packing tightened before damage occurs. Screw-type stuffing box glands apply an even pressure for packing and eliminate uneven packing wear and scoring of piston rods.



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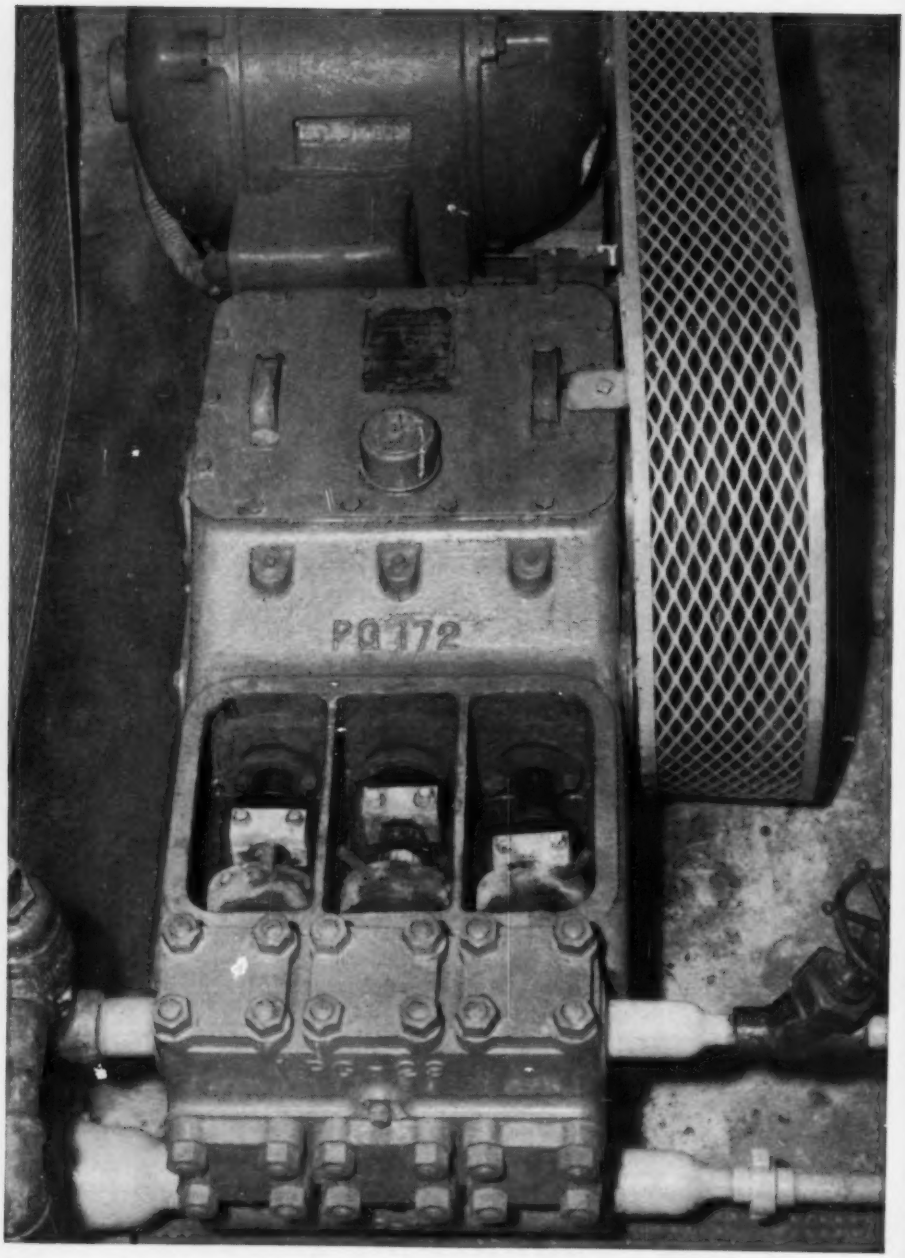
SP901

Gardner-Denver oil field quality well servicing and waterflood

- Water injection
- Salt water disposal
- Water supply
- Water feed
- Filter backwash
- Work-over
- Acidizing
- Cementing

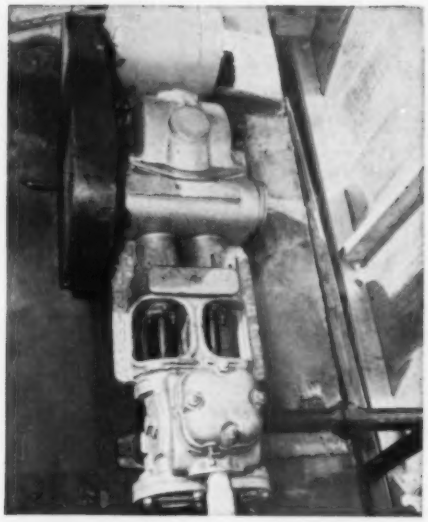


INJECTION SERVICE—Gardner-Denver 2¼" x 3" PG-3 triplex plunger pump on waterflood project.

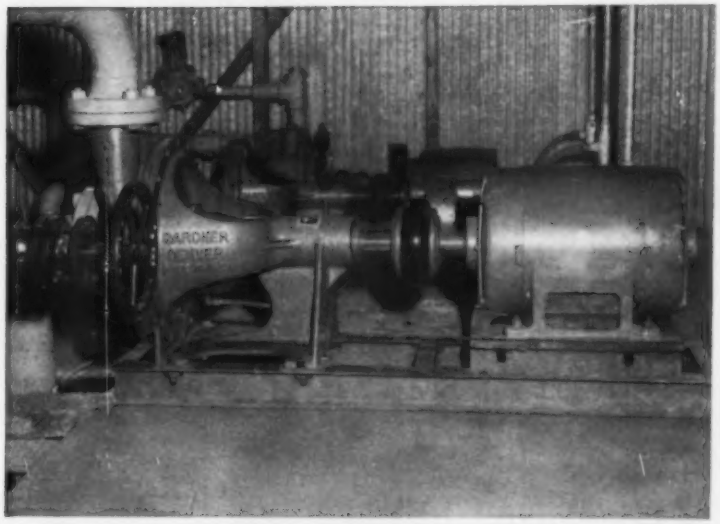
FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

pumps for service

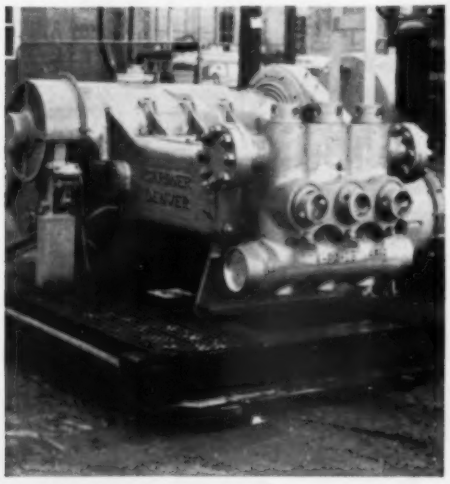
Your Gardner-Denver petroleum specialist has the know-how, field experience, and resources to help you select the right Gardner-Denver pumping equipment for your application. Call him for consultation, or write for bulletins.



WATER SUPPLY—Gardner-Denver 3″ x 4″ AE-AXE duplex reciprocating pump supplying waterflood treating plant.



FILTER BACKWASH SERVICE—Foreground: Gardner-Denver 3″ BE centrifugal pump on waterflood installation. Directly behind: Gardner-Denver 1″ CE centrifugal water feed pump.



CEMENTING SERVICE—Gardner-Denver PA-8 triplex plunger pump on well cementing application.

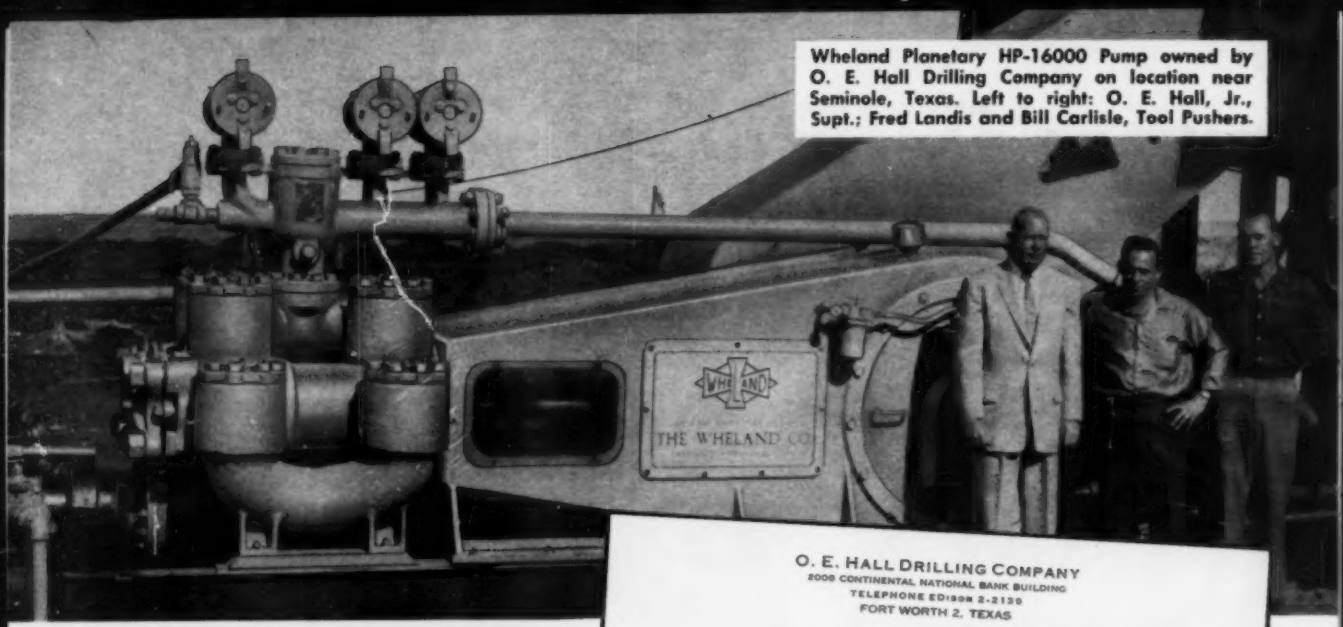
WELL KILLING SERVICE—Model PE-5 triplex plunger pump on offshore barge. Note compact Gardner-Denver speed reducer mounted directly on pump shaft.

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Ave., Toronto 16, Ontario
Gardner-Denver International Division, 233 Broadway, New York 7, N.Y.

Petroleum Offices: Casper, Cleveland, Columbus, Corpus Christi, Dallas, Denver, Durango, Edmonton, Ellinwood, Evansville, Houston, Huntington, Jackson, Kansas City, Lafayette, Los Angeles, Mexico City, New Orleans, Odessa, Oklahoma City, Pittsburgh, San Francisco, Shreveport, St. Louis, Tulsa, Wichita, Winnipeg



Wheland Planetary HP-16000 Pump owned by O. E. Hall Drilling Company on location near Seminole, Texas. Left to right: O. E. Hall, Jr., Supt.; Fred Landis and Bill Carlisle, Tool Pushers.

"...the pump has improved our operation ...we will be happy to recommend it."

O. E. HALL, Jr.

WHELAND PLANETARY HP-16000 PUMP

Duplex Power Slush Pump

7¾"x16", 600 HP at 65 RPM

O. E. HALL DRILLING COMPANY
2000 CONTINENTAL NATIONAL BANK BUILDING
TELEPHONE EDISON 2-2139
FORT WORTH 2, TEXAS

February 16, 1960

The Wheland Company
Signal Mountain Road
Chattanooga, Tennessee

Mr. Gordon L. Smith, Jr.
Manager Rotary Drilling Equipment Sales

Dear Mr. Smith:

We thought you would be interested to know how pleased we are with the performance of our Wheland Planetary HP-16000 Pump. It is the smoothest running pump we have seen. The big gear reduction makes possible such a small sheave and the pump pulls very easily. We are also impressed by the compactness of the gear cartridge and the smooth performance of the new circular crosshead. In the several wells we have drilled thus far the pump has improved our operation in terms of penetration rate and savings in bits. Also has exceeded our expectations.

All of these wells have been located in West Texas. We operate our rigs throughout the Permian Basin covering a depth range of 4, 500 feet to 12, 500 feet with modern equipment.

We want to commend The Wheland Company for stepping forward with this improved design in slush pumps, and we will be happy to recommend it.

Very truly yours,

O. E. HALL DRILLING COMPANY
O. E. Hall Jr.
O. E. Hall, Jr.
Midland, Texas

WHELAND

ROTARY DRILLING MACHINERY

THE WHELAND COMPANY
CHATTANOOGA, TENNESSEE, U.S.A.

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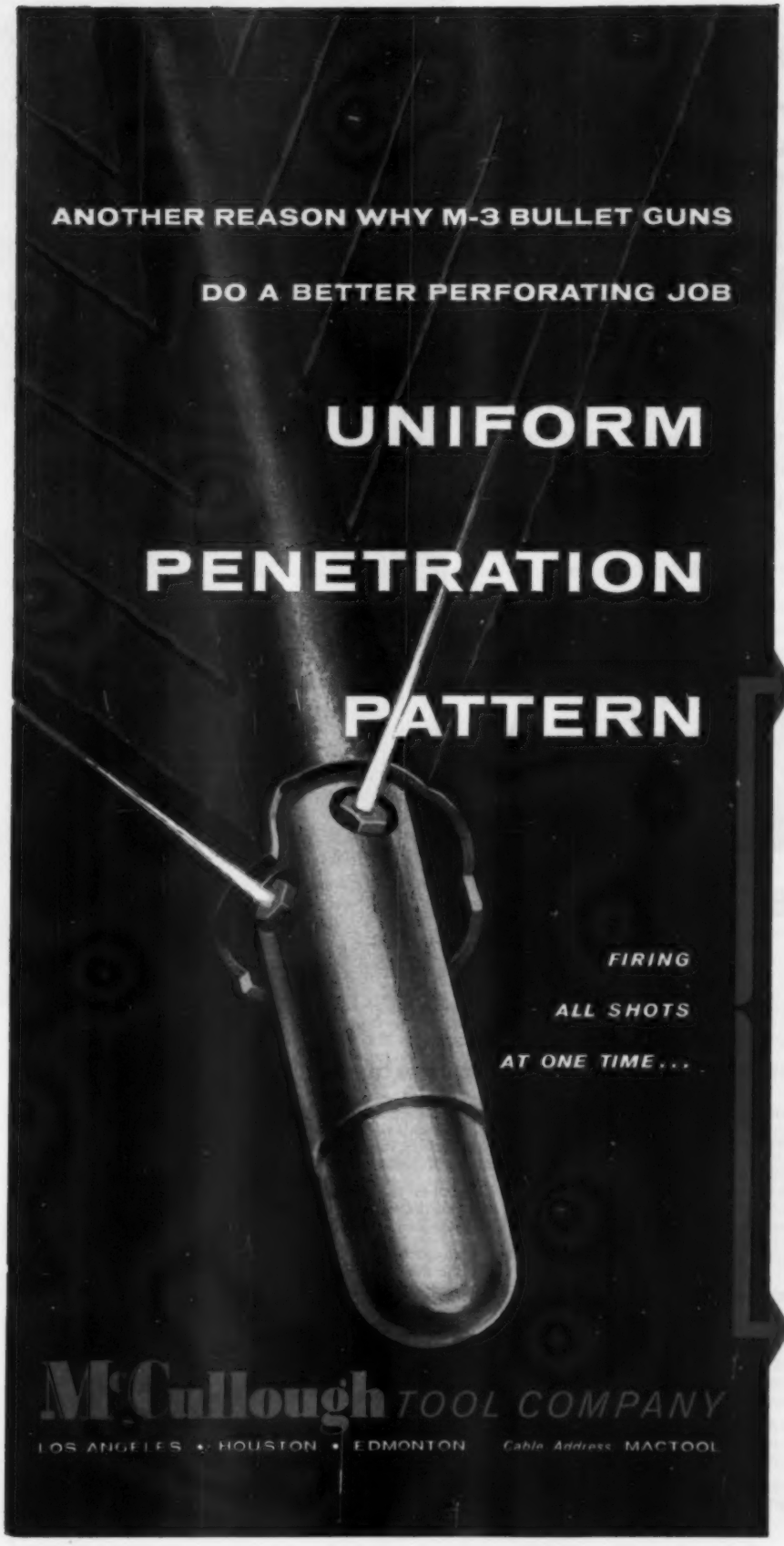
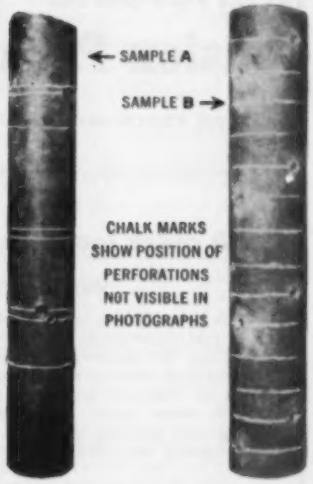


Deep, evenly spaced perforations that *uniformly* cover the productive zone – assure you of the most effective perforating job – and that's what you get when you shoot for production with McCullough M-3 Bullet Guns.

An M-3 Gun fires all shots at one time while the gun is motionless in the casing. Thus, perforations are the exact pattern of the chambers in the gun – in any shot density desired.

Combine McCullough's precise depth measurements with deep, evenly spaced perforations covering the *entire* pay zone and you get maximum drainage from formation to well bore – best possible production.

prevents bunching of shots in one small area in pay zone, giving insufficient coverage – prevents scattering of shots over a wide area, possibly missing the pay zone entirely. Sample A (actual photo of pipe recovered from well) shows the erratic shot pattern produced by a gun firing one shot at a time. As each shot is fired the upward thrust of released gases causes the gun to dance up and down.



eliminates the danger of possible pipe damage or failure. Too many perforations in one spot or in a coupling can cause pipe to part if it is in severe tension. Sample B is an actual example of six shots per foot fired by an M-3 Bullet Gun. Note the uniformity of shot pattern – no danger here of seriously weakening your casing, and you get the most productive perforating job possible.

WHAT MAKES A good waterflood Packer?

Waterflood service demands a packer that's long on performance and short on cost. The picture shows one that is. It is lean and clean, short and compact. Its packoff is positive and dependable, it has great holding power, it is easy to set and retrieve. What makes all these things possible in a low cost packer? See the facts below.

BAKER

Model A Retrievable Tension Packer

To get Bulletin 334, write Baker Oil Tools, Inc., P. O. Box 2274, Terminal Annex, Los Angeles 54, Calif.

BAKER OIL TOOLS, INC. / HOUSTON / LOS ANGELES / NEW YORK

A quick look at the facts about this important retrievable pressuring tool

WHY IT WORKS SO WELL

A Baker Model A Retrievable Tension Packer is compact (and economical) because it is simple. Baker rocker type slips, for instance, have both simplicity and superior holding power – a good combination in any pressuring tool. They are one of the great advances in slip design in recent years. This packer also has a performance-proved packing element – and a full bore that permits running wire line tools or instruments.

WHERE AND HOW TO USE IT

1 It gets its main play in waterflooding.

2 It's also a squeeze packer for simple pressuring operations where you don't need the supervision of a Baker tool specialist. For instance: when fracturing in shallow or low-fluid-level wells.

3 There are times when you may want to leave a packer in the well after a pressuring operation. The low cost of a Baker Model A recommends it for such service.

4 There are also times when you may *have* to leave a packer in the well. For instance, when you've got defective casing and there's doubt you would be able to retrieve *any* packer. You can leave one of these low cost packers in the well and knock it down out of the way with little trouble or expense.

5 You can set and reset any number of times in one trip. It is rugged enough to be used many times in many wells.

6 It is simple to maintain and redress. Standard parts are available from Baker's many field service locations.

HOW TO SET AND RELEASE IT

A simple and reliable J-Slot makes this packer very easy to set and release.

1 To set packer, you rotate tubing ¼ turn to left to unjay the slips, then apply tension to pack off.

2 To release, you relax tubing tension to relax packing element and permit slips to retract, then rotate ¼ turn to right to lock them in retracted position. Now you can retrieve.

3 There are two safety release systems.

The outlook for . . .

FUTURE PROGRESS IN PRODUCTION

An exclusive interview with prominent research personalities at our major research facilities . . . read what they say about the outlook for research in these times

JACK W. WILLIAMSON, *Editor*

PRODUCTION PROGRESS is the life and breath of the petroleum industry. From a long range viewpoint, production progress is just as important in a time of over-supply, such as we are in today, as it is in a time of shortage. Because of the current economic situation our greatest need is to learn how to find, develop, and produce oil at less cost than is possible today. The key to this situation in other industries has been found largely through aggressive research . . . and the petroleum industry must realize that its key to progressively lower costs will also be found in an aggressive research and development program.

New Concepts Needed

Because of our great need for entirely new concepts in both equipment design and operating techniques, it was deemed appropriate to present to our readers a cross-section of "capsule statements" directly from several of today's leading petroleum research people. We could not give them space for all their thoughts, but rather asked them to answer forthrightly several specific questions we suggested, or to make a summary statement along these lines of thought.

More Money Needed

Although the petroleum industry is annually spending large sums of money on research and development work, it actually spends a much smaller percent of its annual gross income on research and development work than does any other major industry.

Research and development work has become so important in the manufacturing industries that the national average for projected research work in the next decade indicates that for every $6 spent elsewhere, $4 will be spent on research!

Compare this to the petroleum industry record of sometimes less than one percent of its gross revenue for research, or hardly ever over 3 or 4 percent. These relatively low expenditures for research in past years may explain why we are still using, in some cases, the identical equipment that came into use as long as 30 years ago. In most industries you can hardly find equipment this old in company museums.

What Is Research?

Let's examine briefly, just what research really is. Progressive man has always been engaged in research activities. That's how we came to know the terms "trial and error" and "leave no stone unturned." These are still good research techniques . . . and you don't have to have a major research facility to put these tools to profitable work for your company right now.

Let's look at some additional definitions of research: "changing things, in a serious attempt to improve" . . . to challenge . . . to put to the proof . . . to institute and make exhaustive investigations . . . to search and analyze . . . to pursue and explore . . . and to audit and sum up the facts. In simple terms, this is research! Couched in these terms, research can be employed by every company. Its benefits are limited only by you and your company's imaginative efforts.

Research Objectives

What are some of our industries most pressing problems? In exploration, we must find faster and lower-cost methods of locating stratigraphic as well as the many remaining structural oil traps. Leasehold costs are mounting daily and this vast expenditure must be greatly reduced. This money should be more profitably invested in research, drilling, and producing activities.

In drilling we need a faster, lower-cost method of cutting rock. Bits, hydraulics, and muds have greatly improved, but it is still taking much too long to drill hard formations. We must find a better and lower-cost solution than we presently have available.

In the field of production, all processes must be directed toward the goal of producing more than 80 or 90 percent of the oil in place . . . as soon as possible and at the lowest possible cost. These are only a few of the pressing research objectives that the oil industry is deeply concerned about today.

Research Is Not A Luxury

In the past, research in the petroleum industry could be neglected to a degree and the industry still survive, but today research cannot be neglected . . . and it is definitely not in the category of a luxury item. Other industries have been confronted with a greater need for aggressive research and development work for many years but now competitive conditions are forcing the petroleum industry to accelerate this phase of its company activity at an increasingly rapid rate. It must do this as one company competing against another.

Nationally, the industry is faced with serious competition from foreign oil which is produced at much less cost. While this condition may not last over 3 to 5 years, this is too long for any but the strongest of companies to survive . . . unless

small, as well as large companies, learn how to find and produce oil much cheaper than is being done today.

Most cost-saving developments in use today came about from diligent research yesterday. And this will be true for all significant future cost-saving developments. Someone must study (research and develop) and solve each important drilling and producing problem, if a profitable and worthwhile saving is to be made. We must all realize that every future aspect of the petroleum industry is dependent in the long run on how successful today's research and development work will prove to be in tomorrow's field operations. Actually, we are experiencing today the benefits and the penalties of yesterday's research and development work, and we are casting the future success of the petroleum industry by today's research and development activity.

Research Benefits Many

Successful research has almost unlimited value, not only to the successful researcher, but to all others who come in contact with a new discovery and learn how to use it properly. For example, the major research facility that initially developed hydraulic fracturing benefited greatly, but in total, our entire industry benefited even more. The small royalty fee paid to use this process to make a dry hole a small commercial success, or possibly a very profitable venture, was well worth the royalty fee.

Again, consider the significance of research and development work in jet and rock bits and bit hydraulics. How much less oil would we have without these monumental research and development accomplishments. There are many others without which the petroleum industry would indeed be in sad shape today. Many of us might still be riding bicycles and vacationing at home instead of across the nation or perhaps on the other side of the world.

I can think of one of today's prominent companies which took a license for a newly developed service and worked so hard selling it that one day it bought out the licensor. So, many others benefit from important research and development achievements other than the successful researcher.

Be Willing to Change

Perhaps the most difficult job all of us have to do, is to condition ourselves to change . . . radical changes . . . and repeated changes. To make the best use of new developments we must develop our ability to absorb changes rapidly and learn to appreciate fully the immediate and far-reaching benefits of change . . . to each of us individually, our companies, our nation, and the entire world.

Adapting one's self, or a business, to a change is not easy, for it can often mean additional expense with only a chance of reward or improvement. It is a very painful process to us. It sometimes means disturbing the often satisfactory *status quo*. However, many once successful business men can attest to the folly of not aggressively accepting well founded and soundly developed change. Your competitor is going to incorporate these worthwhile changes in his company and if your company does not its future can be only lucky mediocrity, or complete failure.

Operators who are trying to survive the present and apparently continued economic squeeze solely by cutting back cannot survive indefinitely on this premise alone. Successful research puts a company on the offensive and every ball player and business man alike knows that you have to be in this position before you can score.

Progress Through Research

It is our sincere hope that this article will give you an insight into the thinking of today's research and development leaders . . . and how research might help you, not only to solve your future problems, but many of the problems that keep you from producing more oil at less cost today.

George Roberts, Jr.
Manager, Research Department
Pan American Petroleum Corporation, Tulsa, Oklahoma

What do you consider important areas of investigation that might lead to a significant reduction in production costs?

A look at the distribution of costs in production suggests that any significant reduction in actual drilling and well completion costs will provide major economic benefits to the oil industry. Two major answers to cost reduction become obvious: One relates to the actual drilling and completion costs of a well and the other to the elimination of drilling unnecessary development wells in a field. Research, both in the past and that projected in the future, shows considerable promise for improvement along these lines.

Several improvements in the basic rotary drilling process are now in either the research or field-testing stage. These developments will gradually bring about further cost reductions, extending the already established trend of reduced contract drilling cost per foot observed during the last 10 years. This achievement was made in spite of increased cost of labor and materials. We would expect these improvements to show up in four major areas: (1) the superimposition of vibration or percussive blows on the conventional rotary drilling process (this is already possible when drilling with air or gas); (2) perfection of near "clear water" drilling fluids to overcome the undesirable features of high-solids-content muds; (3) improvement in bit design to take advantage of the forces created by superimposed percussive blows; and (4) the actual programming of controlled drilling weight, rpm, etc., as related to bit wear in various types of formations to achieve maximum bit life and maximum penetration rate with each run.

There is an increasing trend to initiate oil development with wide spacing—sometimes 80 acres, sometimes 160, and even 320 acres per well. This seems wise. Both field performance and laboratory research have proven that, in many type reservoirs, well density has little or no significant influence on recovery efficiency. If fields are initially developed with wide spacing and reservoir performance becomes known, research can aid in determining optimum well spacing pattern. Drilling can then be programmed to take full advantage of the recovery method involved. This type of development program can make a major reduction in cost per barrel produced.

How do you think the productive capacity and the crude oil reserve picture in the United States might be influenced by research?

It would be unfair to credit research for all improvement in recovery efficiency—nevertheless, research has played and will continue to play a major role. We believe that improved technology during the next 50 years will permit fluid injection to produce some 85 billion bbl of oil along with the production of approximately the same amount of primary oil. Perhaps another way to gage the impact of research and

technology on production is the effect on recovery efficiency. We believe that technology as it has evolved and is applied is now resulting in the recovery of almost 35 percent of the total oil discovered to date in the United States. By the end of this century our total performance should be approaching a recovery of 60 percent of the total oil discovered by that time.

What are some of the major problems in getting research developments into field use?

Many research developments have to go to the field when they are not yet perfected. This is a vital step in a research program. There is a natural reluctance on the part of operators to underwrite costs of testing something that may turn out to be a failure in the specific application. Every superintendent is very cost-conscious. To take some of the risk from his shoulders, cost-wise, we have found it very helpful to accept field charges on our research projects for field testing new ideas. If subsequent tests are planned and the odds improve as to the expected beneficial results, it is then much easier to let the field test stand on its own. The operating superintendent then feels that he has a chance to save money by carrying out the test.

Often it seems apropos to interest service companies or drilling firms in cooperative field tests. Here again, there sometimes exists an obstacle. However, an aggressive service company or drilling firm will cooperate in such tests even though success could force them to change some important established service.

What should operating personnel know about research and development activities?

We believe that operating personnel should have a part in planning research objectives. They should be kept informed of developments coming out of their own as well as other research organizations. Research is staffed with specialists —at least personnel become specialists in the areas of work they follow. These specialists can be of great assistance in helping operating personnel solve unusual field problems.

What are some of the more significant past accomplishments that have benefitted drilling and producing operations?

A listing of these accomplishments to recognize many of the important specifics would be very lengthy. Therefore, I will mention only some of the broad accomplishments. This should justify faith in the probability of future accomplishments.

In well completion, fracturing, with all its ramifications, and the permanent type well completion techniques are noteworthy.

The development of chemical corrosion inhibitors and cathodic protection for oil well tubular goods, while not glamorous, is saving the industry millions of dollars a year.

In drilling, the application of better mud hydraulics (the jet bit), lost circulation additives, straight hole drilling, air drilling (water handling and water shut-off methods and the percussion drill) have all contributed to reduced drilling costs.

In fluid injection, miscible flooding and fire flooding with a number of variations have come out of industrial research laboratories, along with a number of technological developments which improve their chance of success. While still new, and their application must be subjected to careful study, these methods are being tried, and occasionally on a large scale, in an increasing number of areas.

Based upon this performance it looks like faith in the future is justified.

What are some of the more important specific objectives at which research is now aimed?

Well, first of all, improvements and new developments in the past decade are still subject to refinement and considerable effort will be directed to that end. Perhaps some of the most important new achievements that we can hope for might be as follows:

Single well tests combined with special logging surveys to pilot recovery methods and characterize interwell formation characteristics would be a worthwhile development.

Development of fluid injection techniques for improving sweep efficiency and conformance in fields where there is extreme contrast in permeability and/or mobility ratio poses a real challenge.

Chemical treatment of water to alter capillary forces at a water-oil displacement front to improve displacement efficiency is still one of our major objectives.

Methods for recovering liquid and gaseous hydrocarbons from immense deposits of viscous oil, tar, and oil shale will be tested and evaluated. This should assure an almost unlimited supply of liquid hydrocarbon fuel on the North American continent even if access to crude from other continents were lost.

Creation of artificial fractures (especially in deep formations) with considerably higher and long-life permeability seems important.

Perfection of a liquid percussion drill to supplement conventional rotary action appears inevitable.

Methods of segregating fluids behind casing are still only partially satisfactory.

George H. Fancher
Vice President and General Manager
Sinclair Research Laboratories, Inc., Tulsa, Oklahoma

What would you consider the most challenging area of investigation leading to a significant reduction in drilling and producing costs?

The most challenging area of investigation for significant reduction of drilling costs includes: (1) development of methods for the direct determination of oil in place; (2) development of exploration techniques for the detection of stratigraphic traps; (3) development of an understanding of the basic fundamentals involved in the breakage of rocks

(the physics and mechanics of rocks); and (4) the automation of simplified drilling equipment.

Geophysical research, coupled with hydrodynamic studies such as are being conducted by the Russians and our own domestic research laboratories, conceivably can lead to an understanding of the mechanism by which oil accumulation at depth may be recognized on the surface. The solution of this problem possibly is the major challenge facing research. Economic exploration methods which will detect stratigraphic oil traps also must be developed.

The area of significant reduction of production costs includes: (1) improved and more precise determination and evaluation of productive zones; and (2) the development of new recovery methods and techniques which will produce all the oil imprisoned in the reservoir.

Experience indicates that many good oil fields are bypassed because we don't know how to recognize their existence, or worse, fail to realize that the reservoir rock contains and is capable of producing oil.

How do you think the productive capacity and the crude oil reserve picture in the United States might be influenced by research?

The present oil reserves (30.5 billion bbl) conceivably could be doubled by development of improved exploration techniques simply on the basis that half of the known oil fields today are stratigraphic in nature. Direct surface detection of underground deposits of oil would increase oil reserves incalculably.

Research has already demonstrated that productive capacity is controllable. The potentialities of such tools utilized in formation evaluation such as well logs of all categories, core analyses and their evaluation, drillstem and pressure build-up tests all have scarcely been drawn upon and the use of these techniques to the extent of their maximum potential can increase reserves substantially. The development of improved recovery methods and techniques can convert a large portion of the more than 200 billion bbl of oil known to exist in oil fields today but presently unrecoverable by known techniques to actual reserves.

What are the major problems in getting research developments into field use?

Resistance to change, an innate and understandable human characteristic possessed by each of us, is a major problem to putting developments of research into use. Operating personnel resist the application of new techniques or conceptions because of the pain of new ideas. Better and continual communication between field and research personnel should help to overcome this handicap.

In exploration, techniques must be standardized because commercial exploration techniques usually are empirical and the effectiveness of the interpretation of measurements is based upon experience. In order to apply a new technique successfully, a background of information must be acquired if field results are interpreted accurately. Research developments which might bring about a radical improvement in the success of exploration are certain to be foreign to the experience of operating personnel and this fact must be recognized and dealt with.

What should operating people know about research and development activities?

Operating people should be kept as fully informed as possible about the research and development activities of their company and the industry. When operating personnel are informed of the aims and objectives of research and of the necessity to venture into areas foreign to their experience, they are able to cooperate in bringing research effort to fruition. The researcher should go into the field regularly and field personnel should come to the research laboratories.

What are some of the more significant past accomplishments of research and development work that have benefited drilling and producing operations?

All significant improvements in geophysical and geological prospecting have come about through research effort. The highest state of development of the reflection seismograph is the direct result of theoretical laboratory and field studies of the acoustical properties of the earth's crust and of the application of research know-how to the design and fabrication of accurate and precise instruments.

Geologic processes are so complex that most of the progress and the application of this science to the problems of the oil industry have come about through research.

Drilling and producing operations have been improved and influenced by research in numerous ways during the last twenty years. For example, the development of the cone bit through research made rotary drilling effective.

Probably the biggest research benefit to the oil industry has been the realization and recognition of the importance of conservation in the production of oil and natural gas. The general acceptance of this principle is an example of a bountiful harvest of research effort. No better example can be found than that of the frequently cited East Texas field.

A more recent development of research of great significance is the hydrodynamic fracturing of wells.

What are some of the important specific objectives at which research is now aimed?

The important specific objectives of research today are revealed by the answers of the preceding five questions, namely direct oil finding and fool-proof location of stratigraphic traps, the improvement in the efficiency of recovery of oil by water-flooding, more accurate evaluation of oil production locations, reduction in the cost of drilling and in the equipping of wells, a better understanding of fluid displacement in reservoirs, increase in the ultimate recovery of oil through the improvement of existing processes and the development of new ones.

C. I. Alexander
Manager, Field Research Laboratory
Socony-Mobil Oil Company, Dallas, Texas

The petroleum industry has clearly documented its evaluation of research and development in the production field by

steadily increasing its support of this activity for about 25 years. Now, more than ever before, it is in position to reap the benefits of far-sighted research policies instituted a number of years ago. Much of the advanced technology needed to effect major economies in drilling and producing operations today is already available. This does not mean that research and development has finished its job. On the contrary, its biggest challenge lies just ahead—to develop diagnostic and analytical methods that will permit intelligent application of the complex technology that has evolved largely during the last ten to fifteen years.

Drilling costs, for example, are subject to substantial reduction through improvement in bit life and the use of closely monitored and controlled drilling fluid programs designed to minimize hole troubles and subsequent down-time. Increase in the rate of drilling while on bottom, particularly in hard rock, will be accomplished through proper selection of drilling techniques and adjustment of drilling variables. Much is to be expected along these lines through the use of new downhole fluid-actuated engines in combination with more ruggedly designed bits. Developments of this nature must be evaluated in the light of knowledge of the variables influencing the failure of rock under downhole drilling conditions, the dissipation of energy under such conditions, and the rheology of the circulating fluid.

The skillful management of our oil reservoirs and reserves will demand the utmost in engineering know-how and the imaginative application of the most recent information coming from our research and development programs. For example, the choice of a well or reservoir stimulation program for a particular field will have to be made through careful study of a variety of alternative schemes that could be used either singly, collectively, or sequentially. Final decisions will then be based on a thorough understanding of the possible consequences of using acidizing, fracturing and/or perforating techniques in a well completion program on one hand, and the application of miscible or immiscible or thermal displacement methods for increasing total oil recovery, on the other. Again, research and development must be ready to provide the basic information so necessary to the engineering analysis of these processes.

In addition to making certain key information available to operations via written reports, research and development must assume a major role in initiating contacts with management and with operations people to further the application of significant new developments. Problems still exist in the area of communications. Personal contacts usually pay off, however, and are the best way to resolve differences and provide improved perspectives in both operations and research.

It seems, for the present at least, that the industry is not so much in need of additional basic technology from research as it is in need of wider and more critically selective methods and techniques of application of basic information it already has "on the shelf." This is a job for both research and development and operations, working cooperatively. In the meantime, of course, research and development will also be concentrating on ideas for the future; for example, drilling on a wire line or small-bore flexible tubing, logging while drilling, reservoir analysis by long-range surface and subsurface prospecting techniques, automated drilling and lease operations, and multiple sequential oil recovery methods. As long as the industry sponsors creative research effort, the new ideas waiting to be put into use will tax our already enterprising operations. This is as it should be.

R. F. Faull

Vice President, Exploration and Producing Research
California Research Corporation, San Francisco, California

What do you consider the most challenging area of investigation that might lead to a significant reduction of drilling and producing costs?

The most challenging area of investigation has been, and in my opinion, will continue to be to recover substantially all of the oil in a given reservoir, economically. The steadily increasing cost of finding new reserves provides ever greater economic incentive. Continual increase of new technical knowledge provides new approaches. These two factors—better economics and new knowledge—set the stage for an exciting research future for oil recovery.

Other areas also offer great challenge: cheaper drilling, economic operation in deep water, more diagnostic logging —yet none seems to have the potential return that oil recovery does.

How do you think producing capacity and crude oil reserves in the United States are influenced by research?

Thirty years ago producing capacity and reserves depended pretty much on taking what you found. The recovery mechanism from reservoirs was mostly pressure depletion with whatever natural gravity-drainage or water-encroachment might exist. Operators were prone to "get the well on the pump" as soon as they could; so they could settle down to managing a predictable performance. By today's standards recovery percentages were low, averaging no more than 20 percent or so in most cases.

In the intervening decades we have learned a great deal about what happens during recovery and have been able to supplement and control the natural processes so that primary recovery now will average perhaps double what it was then. Much of this progress has stemmed from research and it is encouraging indeed to reflect that majority opinion believes we will again double our recovery percentages.

Today many reservoirs are subjected to artificial drive, almost from the start of production, and this will be done even more in the future. Both total recovery and producing capacity throughout the life of the field will be high. We shall truly manage reservoirs.

What should operating people know about research and development activities?

Drilling and producing research today is not an isolated or ivory-tower endeavor. An essential link is continuous, personal, two-way communication between research and operating people at all levels. True, the basic research scientist

needs protection from too much diversion by daily problems, and the harried production engineer on a sick well can't be expected to contribute to long-range research planning; but in between, and this covers a lot of territory, the answer to successful research and its profitable use in company operations depends upon an awareness of the facts of life by the research organization and the proprietary interest and concern about research on the part of operating departments.

It would be difficult to generalize on the problem of getting research developments into field use—they are many. The research department must have a good development to sell, pick the right means to sell it, and then follow through. Good communications again are of great help.

Looking back, what research and development work has been of significant benefit to drilling and producing operations?

Looking back, we owe much of our understanding of reservoir performance to research: the physics of fluid flow through porous media, the thermodynamics (PVT relationships) of hydrocarbon systems, and surface chemistry of hydrocarbon, water and rock systems. Our ability to evaluate penetrated formations depends upon well logging developments which have come from the most sophisticated research in modern physics. Our ability to model or simulate reservoir processes to the extent now possible makes use of high-speed computers and advanced mathematical analyses.

Each of these developments has contributed to our understanding of oil reservoirs and permits us to control or augment natural behavior to increase oil recovery. As a result of technological developments and applications, we can measure probable fluid rock contents by nuclear logs in the bore hole, pick an optimum well completion method such as acidizing, rock fracturing, sand control liners or "cement and perforate," and then decide with the aid of models and computers the best recovery mechanism for the reservoir and then apply one or more methods of supplementing natural energy to achieve this increased recovery.

Looking ahead, what are some of the important specific objectives at which research is now aimed?

Future objectives for drilling and producing research all stem from our need to increase our knowledge and understanding of what really happens during a recovery process and our need to be able to drill to and identify a potential oil sand at the least cost and risk. Some of the important specific objectives are:

1. Increase our ability to identify oil-producing formations at the time a well is drilled, including the capacity of the formation to produce.

2. Evaluate the adding of energy to an oil reservoir to increase total recovery and recovery rate, such as underground heat processes and pressurized fluid displacement.

3. Reduction in the cost of wells by developing more efficient ways of drilling, completion and stimulation.

4. Increase our analytical perspective by taking more into account the nonuniform nature of oil reservoirs. Advances in this direction will depend heavily on high-speed computers, even on ones that haven't yet been built.

L. P. Whorton

Resident Manager, Research and Development Department
Atlantic Refining Company, Dallas, Texas

In this day of over-supply the most challenging area of research investigation is that which would lead to significant reduction of drilling and producing costs. The industry has made recent advances in reducing drilling costs, but there remain significant problems, solution of which would materially improve the situation. An example is the problem of lost circulation, particularly bad in the deep wells of South Louisiana where substantial reserves are almost unattainable with present methods. Similarly, difficulties with production of unconsolidated sand lead to high costs in offshore operations. This would make a substantial difference if solved.

In the field of reservoir operations several high recovery processes would be more widely applicable if cheaper compression facilities were available and if cheaper agents to attain miscibility for miscible displacement were found.

Both producing capacity and crude oil reserves in the United States have been influenced by research but, particularly in the latter category, much remains to be done. One calls to mind the tremendous influence which well fracturing has had on producing capacity, and the more widespread exploitation of secondary recovery methods and pressure maintenance projects will influence both capacity and reserves. Even in the use of water flooding there is much yet to be learned.

We are just now beginning to understand the factors which control residual oil and to be able to predict adequately the ultimate recovery resulting from the use of water flooding. Advancements in drilling and completion techniques allow operation in areas and at depths where it was not feasible a few years ago.

The major problem in exploiting research developments has been their high cost of application. For example, we know how to get much more oil out of the ground than natural depletion will permit, but we have not yet fully exploited this know-how because we have not learned to engineer the process economically. This may represent incomplete research, but it also may represent insufficient ingenuity in engineering.

A major problem in exploiting processes directed at increasing reserves has been the high initial cost, even though total dollars returned, without consideration for time, would look very attractive. Should our regulatory bodies elect to recognize this type of reserve increase in a manner comparable to the recognition given to new reserves discovered by the bit, we may have more opportunity for exploiting research of this type.

A major chore of any research department is that of keeping operating people informed of research activities and findings. Generally, the more the operating people know about what research is doing, the better chance there is for exploitation of research. At the same time, their responsibilities are so time-consuming that it is very difficult to keep them informed without using an inordinate amount of their time.

Better reporting, both oral and written, on the part of research people remains the major stumbling block in this connection. Research needs the help of operating people in assigning relative stakes to improvements in various operations.

Some of the major objectives of current research, including several mentioned earlier, are:

1. Finding a cheaper miscible displacing agent. This is a very difficult job when it is realized that hydrocarbon components of the crude oil are among the cheapest liquids available and are already being used. A corollary to this problem is to find out how to use smaller amounts.
2. Better exploitation of air drilling. Shutting off water, and crooked hole problems, limit the exploitation of this fast drilling method. These will probably be solved in the not too distant future.
3. Reducing lost circulation. Mud costs in some deep wells where lost circulation is a bad problem approach the remainder of the costs combined.
4. Cheaper compression for injection processes. Cheaper air for in situ combustion would result from cheaper compression costs. Cheaper gas for use in high pressure miscible displacement and miscible slug processes would also result from cheaper compressors.
5. Obtaining basic knowledge of reservoir inhomogeneities. Good engineering of secondary recovery projects requires a much better knowledge of reservoir inhomogeneities. The effect of stratification on bypassing is an important aspect of this problem. Other types of inhomogeneities may be important from a consideration of miscible slug dissipation. If we could better predict, through correlation, the type of inhomogeneities expected in a given reservoir we might be able to exploit secondary recovery to a greater extent.

T. O. Allen

Manager, Drilling and Development Division
Jersey Production Research Company, Tulsa, Oklahoma

What do you consider the most challenging area of investigation that might lead to a significant reduction of drilling and producing costs?

One of the basic approaches in drilling research is to recognize the necessity of determining what really must be done to make hole faster and cheaper. First, we approach this problem from the standpoint of finding the best method to make the rock fail. Next, we study the equipment needed to do this job.

Probably the most lucrative short-range drilling research is the improvement of the rotary drilling system, including drilling practices and the fluid system. Also, good progress is being made in the new systems of air and percussion drilling.

In production research, technology can do much to aid understanding of the principles involved in determining proper well spacing. Wider well spacing offers great potential in cost reduction.

These most challenging areas of research might be summarized as: (1) a better way to cut and remove rock, (2) new systems of drilling or improvements in the rotary to capitalize on new and basic information, and (3) technology leading to wider well spacing.

How do you think producing capacity and crude oil reserves in the United States are influenced by research?

There seems to be no question that sound, basic research can have only one result: an increase in productive capacity and reserves.

What are the major problems in getting research developments into field use?

The major problem is getting field acceptance of new and semiproved tools and techniques. In our normal operations, this problem is approached by testing and applying research on a team basis, with our affiliates and research organization sharing responsibility.

In the U.S., the drilling contractor drills over 95 percent of the wells while contributing very little to research. It appears that the contractor needs to make an enlightened appraisal regarding his research responsibility to the oil producing industry. Often when we take a new research development into the field where the drilling contractor is working on a footage basis, we must operate on a day-rate basis in order to make evaluation tests. We feel that the contractors should have some budget to support and inspire research and the evaluation of new developments. Obviously, the many small contractors cannot each have a research program. It does appear quite reasonable that AAODC should have a continuing research program.

What should operating people know about research and development activities?

Since we are part of a world-wide organization, this is a very important consideration. In order for our operating affiliates to take advantage of research and, in turn, for us to understand what their problems really are, they must be "research-minded." This usually results when research and operating groups work closely together to arrive at an understanding of and solution to their mutual problems. Rotation of personnel from the field to research and from research to the field is one proved method of aiding mutual understanding.

Looking back, what research and development work has been of significant benefit to drilling and producing operations?

Of course, everyone will have his own favorite list, but I feel that the development made by Humble Oil & Refining Company on jet bits and bit hydraulics would top my list on drilling. This development initially met with considerable resistance throughout the world, but many people are finding out that jet bits are applicable even to drilling much harder formation than was earlier thought possible.

In producing operations, the developments in basic reservoir engineering concepts, including all types of primary and secondary producing mechanisms, have been of great economic significance. In the field of well completions, hydraulic fracturing and the miniaturization of tools for slim-hole and tubingless completion have been very beneficial.

Looking ahead, what are some of the important specific objectives at which research is now aimed?

Research groups often concentrate considerable effort on problems that, if solved, would not be a major contribution to industry. We feel that research efforts should be directed primarily toward the areas where the most money is spent or where earnings might be increased appreciably. For example, if the cost of casing or tubing represents 20 percent of the total cost of a well, this should receive our attention before some problem that accounts for only 2 or 3 percent of the cost yet has a very high "annoyance factor." We must become money-oriented rather than problem-oriented because the real goal of research is to bring about increased profits through increased income and reduced costs in areas of major expenditures.

One of the most logical approaches to cost reduction is wider well spacing. Research has contributed much to prove the economic folly of close spacing. Unfortunately in many places, the technology has either been ignored or misunderstood. Therefore, as a major aid in maintaining a healthy oil producing industry, wider understanding of this problem is needed.

In summary, research and development in oil producing have a commendable history. But if we essay expenditures in drilling and completion research, we will find that less than one percent of drilling and completion costs is going to research. There is no other industry in the world that spends so many billions without commensurate research. It has been reported that in 1960 all manufacturing industries in the U.S. will spend around 15 billion dollars on new investments and 9 billion on research. So we must ask ourselves, if research is good for other industries, why isn't it good for the drilling and well completion part of the oil business?

H. F. Coffer
Research Director
Continental Oil Company, Ponca City, Oklahoma

What do you consider the most challenging area of investigation that might lead to a significant reduction in drilling and producing costs?

Finding a new method to drill pressurized formations with air or gas. We know penetration rates double or triple when the hydrostatic pressure of a mud column against the rock face is eliminated. The problem is how to do this mechanically while keeping the hole in good condition.

Another major cost reduction can be obtained by determining what the actual well spacing should be for a particular reservoir. Utilization of the new giant computers will allow us to solve the complex flow equations and determine from reservoir fluid and rock properties the maximum spacing which will drain the reservoir economically. This should eliminate unnecessary wells and result in maximum oil recovery from a minimum number of wells.

How do you think the productive capacity and crude oil reserve picture in the U.S. might be influenced by research?

I don't believe the productive capacity will be influenced appreciably. Our ability to produce is already much greater than proration allows. It is true that new stimulation methods probably will increase the wells' potentials, but basically we will be more interested in developing greater reserves. For example, economic use of fire flooding will release tremendous reserves of low gravity crudes which cannot be economically produced by present methods. New methods of pattern floods and expanded use of miscible flooding will increase the percentage recovery from our known reservoirs.

What are the major problems in getting developments into field use?

In our company, we haven't any. We work closely with our production department. When the research idea is ready for field testing, a joint decision by Production and Research is made to determine the best place for the new development. This method works extremely well, with our research ideas put into rapid use. I understand that research groups of some companies face a major stumbling block in the necessity for showing a payout on a research development in its first few applications. There also is the problem of liaison between research and field, since many companies have little or no contact between the research and production departments.

What should operating people know about research and development activities?

Operating people should be familiar with the major direction of research effort. We feel they should have a voice in research planning, so that researchers will be working on problems of benefit to them. Personal contact between field engineers and the research department is desirable since this leads to mutual understanding of joint problems. Researchers have no monopoly on new ideas. Many of our best ideas originate with field personnel who are more familiar with operations. When operating people are cognizant of current research efforts, their ideas and comments contribute to a well-rounded research program.

What are some of the significant past accomplishments of research and development work of benefit to drilling and producing operation?

Some of the most significant accomplishments are fracturing, new logging devices, new muds and cements, development of pressure build-up analysis, fluid loss additives for fracturing fluids, corrosion control, miscible flooding, improved methods of predicting oil recovery from water flooding, fire-flooding, improved tubular goods, perforating, and multiple completions.

What are some of the important specific objectives at which research is now aimed?

Our production research is aimed at reducing production costs and increasing oil recovery. Much of our effort is on increasing the efficiency of secondary recovery methods. We hope to increase our oil recovery several percent by improved design of the flooding patterns, controlled injection pressure, use of miscible slugs of LPG, and use of surfactants. We are currently field testing in situ combustion in one area and plan to expand tests into other areas.

Reduction of sand problems is another specific objective of our research program. Work continues on upgrading tubular goods and on corrosion control in problem areas.

Large computers now are available to aid us in calculating answers to complex flow equations which could not be solved by ordinary methods. We feel this will enable us to calculate accurately what will be the most economic spacing for newly discovered reservoirs. Let's stop drilling wells which aren't needed for adequate drainage! ★ ★ ★

CONTRACT DRILLING OVERSEAS LOADED WITH HAZARDS

There are times when the actual drilling of a well overseas is the easiest part of this entire specially contracted operation. The problems are many and varied . . . personnel, customs, supplies, communication, transportation . . . and the timing of all these factors can mean the difference between a successful operation and chaos

KEITH L. DIEHL
Drilling and Exploration Company, Inc.
Dallas, Texas

DRILLING in a foreign country involves many operations that are not required, or do not exist in domestic drilling operations. While a contractor drilling in the U. S. may spend only a relatively small amount of time moving and in other down-time activities, the foreign contractor usually spends more time moving his equipment, getting it through customs and other down-time operations than he does in actual drilling. This article is a brief rundown on the general mechanics of just what happens to a foreign contractor when he is asked to bid on a well in a foreign country.

The Foreign Contract

When the operator in a foreign country is ready to start drilling, he will select several experienced contractors and do one of two things in order to acquire a bid from them. He will either send a company tender specifying the equipment he wants, or, invite the contractors to submit their own bids outlining equipment they propose to furnish and total contract bid price.

In the company tender, their own engineers and others in the operating company will specify the equipment to be required. Specifications for pumps, drill pipe, drill collars, drawworks and other related equipment will be given. It may also be specified whether the equipment may be new or used and the minimum of fishing tools that will be required and readily available for any anticipated fishing jobs.

When the operator invites a contractor to bid he will send the contractor an invitation to come to the zone of operations. There the operator will tell you how deep they want to drill and what their pipe program will be. You will have an opportunity to discuss in general terms the equipment requirements and to investigate everything in the country affecting the drilling operations. Then you go back home and make up your own proposal. The contractor will itemize the equipment he will furnish, complete with the sizes and other specifications. This bid is then submitted to the operator.

Now in my opinion, this is good because it eliminates a lot of contractors who are not experienced in foreign work. An inexperienced contractor will often overlook important items which the operator will recognize immediately and throw out his bid. It is bad on the other hand, in that some operators are inclined to overlook these omissions because it makes for a cheaper bid. Invariably, the way it winds up when the contractor underbids, is that the operator has to bail him out and in the end it actually costs him more than anyone else.

It is a predominant practice at this time for the contractor to furnish his own camp as well as his own transportation equipment. This means supplying heavy oil field trucks or whatever it takes to handle the equipment used on this job. An adequate air conditioned camp and the necessary heavy trucking units for a desert operation represents an investment almost equal to what is required for the rig.

Generally speaking, the contractor will be required to furnish perhaps one million dollars or more worth of equipment, for even a one rig operation.

In foreign operations local conditions are probably the hardest to evaluate. You also have to predict how your operations will affect local conditions after you get there and start to work. Some of the items which must be checked and which have nothing to do with a drilling operation are: quality and availability of housing for married status personnel, the voltage and frequency of electric current in the city or town selected for headquarters, necessary procedure for work permits, school facilities if any, and the type and quality of food available.

There are three contract rates which the operators will pay for your equipment and services. The "intransit rate" is paid from the time your equipment leaves the United States until it arrives

This article is based on a recent talk by Mr. Keith Diehl before an informal luncheon meeting of the Petroleum Engineer's Club of Dallas. The talk was not designed to comprehensively cover foreign drilling operations, but only to review informally and in general terms, some of the problems of drilling overseas. Drilling and Exploration has kindly permitted *The Petroleum Engineer* to bring to its readers this condensation of Mr. Diehl's talk. Mr. Keith L. Diehl is vice president of the subsidiaries of Drilling and Exploration Company which are engaged in contract drilling operations.

at the port of debarkation. During the time of such operations as unloading the rig, moving it to location, rigging up and waiting on cement, the "shut-down rate" applies. It is the objective of these two rates to provide the contractor overhead and his actual costs while his equipment is tied up in long moves and non-drilling operations. It is a necessity because it would be almost impossible to provide a footage rate that would be fair to either party if it were intended to cover all type costs.

The third rate is the usual "day work rate" or, "modified day work rate." The modified day work rate is used widely and is popular with both the operator and the drilling contractor. Under this rate the contractor receives a certain amount every day which is planned to cover his actual minimum operating costs. Then in addition, he will be paid a set amount for every foot of hole drilled. This provides the contractor with incentive to make a lot of hole which will benefit the operator as well as the contractor. At the same time, the risks are considerably reduced in that he is guaranteed his cost. It is probably the best type of foreign contract from the standpoint of both the contractor and the operator, and is the result of many foreign drilling operations by many operators.

Foreign Taxes

Corporation income taxes in a foreign land are often very difficult to determine. The government will tell you that the corporation income tax is say, 15 or 20 percent. However, most countries do not even have a clue as to how important the allowed equipment depreciation rate is to the contractor. Since depreciation is one of the contractors' most significant costs, the difference between actual depreciation, based on the useful life of equipment, and depreciation allowed for tax purposes in some countries can result in a taxable income far in excess of economic income. So even with a low corporation income tax rate your effective tax may turn out to be as high as 55 or 60 percent.

In one country we are allowed only a 10 year depreciation on our rig and drill pipe and I am sure all of you know drill pipe will not last 10 years.

Letter of Intent

Let us assume that, as a contractor, your proposal has been accepted by the operator. Because there is a time lag between acceptance and the signing of the formal contract, you need to obtain a letter of intent to protect your investment purchases for this contract. This is necessary because the operator could change his mind in this interval after the contractor has purchased or obligated himself for perhaps a million dollars or more of equipment. Otherwise, the contractor could be left holding the bag with all this new iron and as you well know he could not sell it back to the supply house, even if it were new.

On the Arabian Sea Coast, drilling and exploration crews had to build this rock and sand pier to unload its rig and equipment. The equipment was lightered in a small boat from the ocean going vessel to this pier, drug off and hauled ashore. This type operation can be very time consuming and difficult.

After you get the letter of intent, you set the wheels in motion for your purchasing department to go ahead and purchase the equipment and supplies which you will need for this operation. The delivery date then becomes quite important and your timing is geared closely so that you get all this equipment gathered up to some point of embarkation on schedule.

Timing Important

As an example of how important timing can be, let me relate a very sad experience we had last summer. We were shipping a rig to one country and we knew that trucks for transportation there were practically non-existent. The oil boom was going at such a pace that every heavy truck was at a premium, so we decided to send a 30 ton truck. Everything was timed to leave Houston on September 30 and we had all the equipment loaded on time except this 30 ton truck. Before we could get it to Houston and loaded, the longshoremen struck and it was not possible to get the truck loaded. The ship sailed, pulled into the destination, unloaded, and there we were without a truck to haul anything out of the customs yard . . . and customs did not have room to keep our equipment. Fortunately, we had a 50 ton float in this shipment and a little 7 ton truck. So we put the two together and that's how we hauled our equipment out of the customs yard. That's foreign operations!

Crating and Shipping

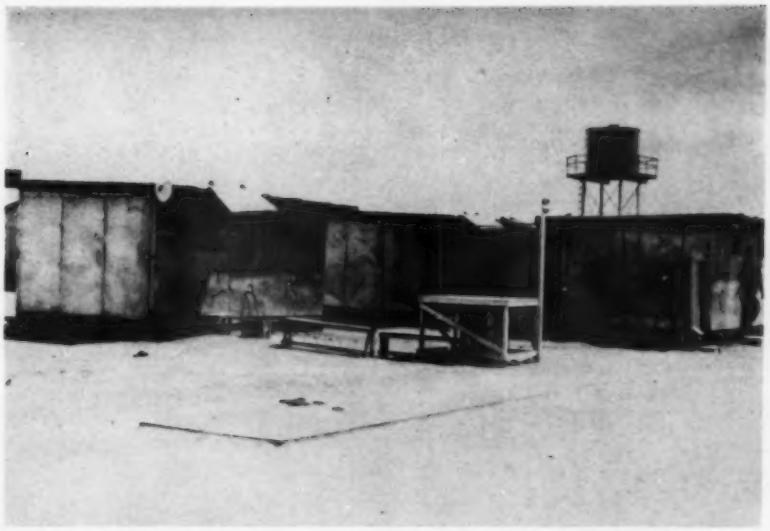
After all your equipment arrives at the U. S. port of embarkation, it is assembled to be packed and boxed for export (this is quite an expensive item). Then it has to be loaded aboard ship.

We had a smelly trick pulled on us a couple of years ago. We arranged for this so called chartered vessel to haul a rig of ours to Central America. The captain swore up and down it was a straight charter from Houston. So we loaded our big rig aboard and he immediately sailed to New Orleans where he took aboard 2000 tons of fertilizer . . . right on top of our rig! The whole works then sailed to Costa Rica and unloading down there was really something. Maybe 50 tons of fertilizer would be unloaded and then a piece of our equipment, more fertilizer, and then more equipment! We were tied up 14 days before our final piece of iron was unloaded.

Customs Procedure

When the rig arrives at the port of debarkation, the first battle a contractor has is with the customs people. Generally, they are quite unfamiliar with petroleum equipment and this sometimes creates considerable delay as it may be necessary to personally identify each piece of equipment on the shipping list. It is often extremely difficult to get the equipment cleared through customs.

We usually are required to have all of our documents translated into the language of the zone of operations and



Typical set-up at an Arabian location. Each skid mounted hut houses two men and two or more can be put together for dining, kitchen, or recreation rooms. The table in the foreground is handy for many uses, among them, evening movies.

this can be very expensive. Translation is time consuming and very expensive because the documents for a drilling rig and the auxiliary equipment are quite voluminous.

Warehouse and Supplies

As soon as you have debarked you necessarily have to set up your camp and warehouse. The warehouse gets priority because you can't fire up the rig when the parts are scattered all around and in some box. We have tried it repeatedly and everytime we find that things get so confusing that it is impossible to keep a proper accounting of costs as well as incurring much unnecessary expense.

Maintaining proper type and volume of supplies takes very close coordination between your materials man and your purchasing agent back home. There is a constant stream of supplies in transit to replace the stocks you are consuming in the daily operations.

There are interesting sidelights that you run into in this category. For example, one operator insisted upon furnishing the fuels. In this particular case everything was unloaded on the beach and there was no way to get fuel to the rig by land. So the operator set up a supply line consisting of 2 sailboats which could haul 50 bbl of diesel fuel each.

The procedure was for the boats to anchor off the beach and wait for the tide to come in, then the drums were kicked off into the water. The drums would float up to the beach and the crew would then drag the drums out of the surf, load them on the truck and take them to the rig. The rig was using about 20 bbl of fuel a day and the two boats could just keep us supplied, provided the weather was good. Otherwise we were without fuel and it was often that we were down for this reason.

Forecasting Bit Selection

A problem of considerable importance is the selection of bits for the entire drilling program. Normally, the operator furnishes the bits but the difficulty comes in having to select the right bit that will be used some six to eight months hence. If you try to cover every eventuality you can get a tremendous amount of money tied up into this type of inventory on a six to eight months lead time. So the bit inventory has to be trimmed down to approximately what will be used. Invariably, this selection, of the approximately minimum required bits needed for generally unknown drilling conditions six to eight months hence, will go far astray. You can't return the bit or exchange because of the time, so you put them in the ground and use them up. This of course, reduces the efficiency of the drilling operation considerably.

Communication Difficult

Communication is also a tremendously difficult problem. This is particularly true when you first go into a country and try to get your cable procedure set up. Usually telephone communication is non-existent except in Europe. We have tried to call from coastal cities to the U. S. but it is still quite difficult. Sending messages by cable has many difficulties too, as the cable received in the Dallas office from the field may have an entirely different meaning than what the superintendent originally sent.

Biggest Problem . . . Personnel

Perhaps our biggest problem is the hiring of qualified personnel. That has become a real problem this day and age! We feel pretty concerned about it, in that our basic trouble is that you just can't get the farm boys to come to the oil field. They can make more money as a plumbers helper, a carpenter, electrician, or most any kind of labor. A roughneck job just doesn't attract them any more from the financial point of view. We are not the only one faced with this problem as other contractors are having this trouble. Pay scales are just not high enough to make it worth their while.

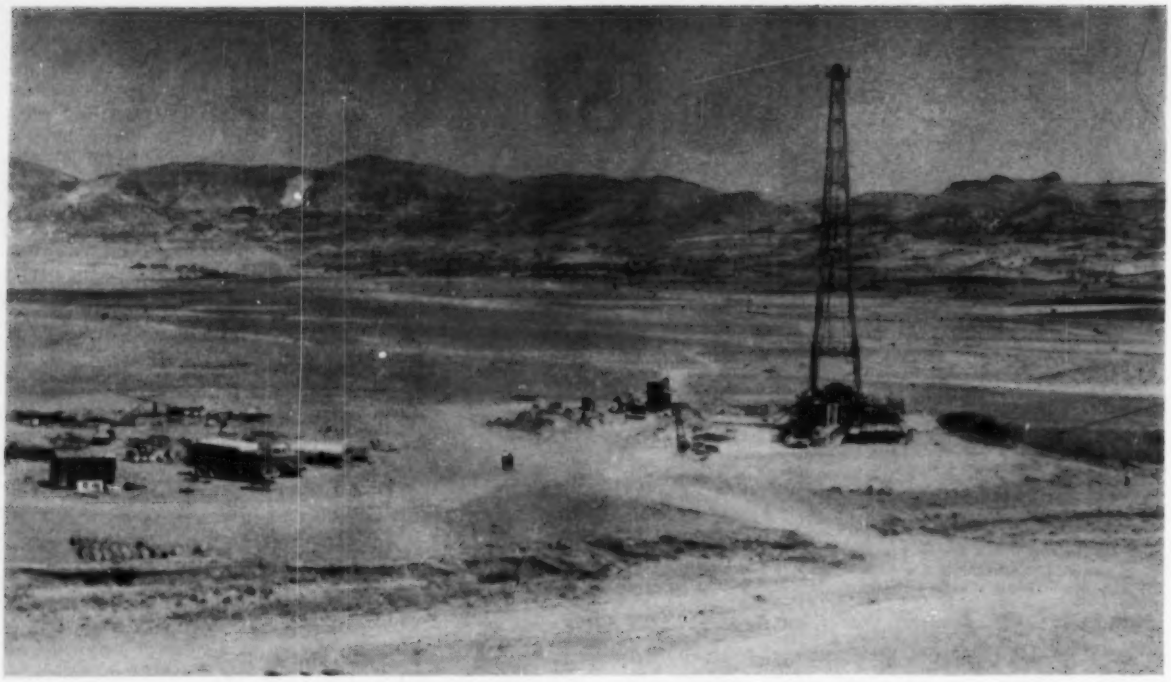
The roughneck has to use his own car and he doesn't have a steady job. He will probably work a month and be off several days and you just can't attract qualified people any more under these conditions. What we are finding is that the average age of our drillers, toolpushers and superintendents keep going up and up. We are not attracting many good young men any more.

On a foreign job we normally furnish from the U. S. a superintendent, toolpusher, mechanic, drillers, and in some cases a derrick man instructor. This man is also generally a qualified driller and preferably fairly young, so that he can get up and down the derrick many times a day to teach the natives how to work derrick. The mechanic must also be a qualified welder, electrician, refrigeration man and jack of all trades. He is one of the key men on the crew.

In addition, we need a materials man to handle our warehousing of spare parts and other supplies. Control of spare parts and supplies in a foreign land is one of the most critical jobs for a drilling contractor. This is true not only from the standpoint of preventing theft or misplacement of equipment, but also from a standpoint of having a continuous inventory to order replacement parts before they are needed.

We also furnish in some cases a doctor whom we normally hire from Europe. Sometimes a mud engineer is required who must be an American. In recent years we have been fortunate in obtaining young European accountants who are very good.

As you can see, the superintendent and toolpusher on these jobs have to be much more qualified than he would for an operation here in the United States. For example, he has to be completely familiar with fishing tools. Not only how to run them, but how to take them apart, repair them and get into operating condition. Since this is not part of a toolpushers job here in the United States, it is something that most domestic toolpushers do not know how to do.



A Turkish rig location . . . hot, rocky and sandy. This view was taken from the camp site on a nearby hillside.

The same thing holds true with cementing and testing operations. The toolpusher and superintendent have to know every angle of cementing and squeezing operations because there is no one else to help them. A few service companies have begun to move into foreign operations, but in most cases we are still working in areas where the toolpushers and superintendents still have these operations to perform. Finding people of this caliber who are stable enough to work in foreign operations is a real tough job.

The jobs we fill overseas with U. S. personnel are pretty demanding. Sometimes, the company will hire a man that can not fulfill all his responsibilities. This is unfortunate for both the man and the company. In one operation in the Middle East, it cost the company $3000 to turn just one man around. In other words, if a man were to quit, by the time we brought him home and sent one back the costs were around $3000. So we try to screen these people as closely as possible.

Of course, in a foreign contract, the main consideration is salary and we pay differently on a foreign job than we do in the U. S Some contractors pay a little differently than others, but overall the men receive about the same effective pay. I'm speaking only of expatriate people in foreign countries, whether European or American. He gets a base pay, vacation and a bonus. However, the vacation and bonus is only obtained if he completes his contract.

The company will pay 100 percent of all his medical care while he is in a foreign country. And his family, if on married status, is covered by our group health insurance plan. Transportation expense to and from the zone of operations for the employee and his wife are also paid by the company.

Each foreign operation is classified as either single or married status depending on accommodations. If a man is married and it is a married status job, we will encourage him to take his wife if decent housing in a nearby city is available. We have found in general, this is a good policy because the men are happier when their wives and children are with them. However, there are many times when the family cannot be taken because there is no provision for schooling. But if his children are under school age or he has no children at all, he can usually take his wife. In this case we will provide him with a living allowance to cover his rent, utilities and food only.

Any expenditure other than these are paid by him. For example, an employee may want a large number of servants for his household, but he will have to pay for this out of his own pocket. Sometimes when we happen to have a single man on a married status job where the other men have their wives with them, the single man will resent the benefits being provided for the married man and not him. However, it is our contention that the additional amount is justified for the married man.

Overseas personnel may break their contract and it is our responsibility to get him back home. However, he does lose his vacation privilege and vacation pay. We may also break the labor contract when the employee discredits our company or the operators company. If his health fails while on a job we usually pay the job's full benefits and bring him home where he is kept in the hospital until he is back on his feet.

Now, Throw It In Reverse

At the conclusion of a contract, we have all of these problems in reverse. As far as getting the equipment out you have to crate everything again which is very difficult and expensive. Usually you have already used the lumber which the equipment was originally boxed. Exporting a rig and auxiliary equipment from a foreign country can be just as difficult as bringing it into the country.

The time consuming and difficult operations of going through customs is again experienced. Of course, you learn with experience and one lesson that has been valuable to us, is that we always take out the same weight we took in. You are then faced with the problem of where you are going to ship the rig. Nobody wants the equipment back in the United States and you don't always have a new contract ahead. ★ ★

Mandawa deep test, on the southern coast of Tanganyika, was completed in January 1959, by BP at more than 13,300 ft as a dry hole.

Costly Oil Search in East Africa

SINCE 1951 BP (British Petroleum), in association with Royal Dutch/Shell, has been exploring for oil over wide areas of East Africa. Nearly $19,600,000 has been spent on this work without finding oil.

One of the first operations was an extensive air-photo survey, first over the coastal area of Tanganyika and later over Zanzibar and Pemba Islands and parts of Kenya. Ground surveys, geological and geophysical, followed over much of the area until, at the end of 1954, the first deep-test well was spudded in on Mafia Island, off the coast of Tanganyika. This well took about a year to drill to a depth of more than 11,000 ft. It did not strike oil, but yielded valuable geological information.

The drilling rig was then moved to Zanzibar for the second deep test. In March 1957, this well was completed at 14,281 ft, but again oil was not found.

The site of the third test was Mandawa, on the southern coast of Tanganyika, and drilling began in the spring of 1958. The well was completed at more than 13,300 ft in January 1959, as a dry hole. As with the previous deep tests, much more than the actual drilling had been involved in the Mandawa operation — the building of an all-weather road of 20 miles from the coast to the site to carry heavy equipment, the laying of a 13-mile pipeline from a river to bring water, and the construction of an airstrip. Transportation of the drilling rig and equipment and bulk supplies was chiefly carried out by two BP motor vessels, the "Wrangler" and the "Gowera."

During the drilling of these deep tests, survey work — geological and geophysical, including the drilling of shallow holes for stratigraphical information — has continued over many areas. Nor has it been confined to the land. Toward the end of 1959, a marine seismic survey off the coasts of Tanganyika and Kenya and nearby islands was made from the "Wrangler", a wartime landing craft. And in 1960 the search still goes on. ★ ★ ★

Geologist on field work in the Lamu district of Kenya is aided by local assistant. Exploration also includes geological and geophysical surveys.

The first shot explodes during a geophysical survey in Zanzibar. A well drilled to 14,281 ft in this area failed to find oil.

FIRST QUINTUPLE

Well produces five zones simultaneously from one well through five strings of production tubing. All strings were run at the same time and set with hydraulic packers

WORLD'S FIRST quintuple string completion was recently completed by Sinclair Oil and Gas Company, on Well No. 6, Block 190 Field, Eugene Island Area, offshore from Louisiana. It is the first well in the petroleum industry to produce five zones simultaneously from one well through five strings of production tubing.

Previous completion for Sinclair and other companies in the owning group include one singularly-completed oil well and one quadruple-string completion of four gas zones. Other participating companies are El Paso Natural Gas Company, Peoples Production Company, and Sohio Petroleum Company. Sinclair is the operator.

Well No. 6, located 40 miles offshore in 72 ft of water in the Gulf of Mexico, was drilled vertically with a self-elevating mobile offshore drilling platform.

Set and cemented was a 9⅝-in. OD 47 lb per ft production string casing. In order to produce five or six zones in the well simultaneously, it was decided to equip this well with five strings of 2⅜-in. OD tubing. During the operation a total of six hydraulic set packers was run. Two single-string hydraulic set packers were run and the two lower zones completed as alternate zone completions, allowing production of the other zone upon depletion of the first.

When Zone A is depleted, a plug will be run in the No. 1 tubing string and landed in the landing nipple to blank off the lower zone. Sliding sleeve opposite Zone B will be opened and this zone will be produced through No. 1 tubing string.

Operation will be performed by wire line and eliminates the need for costly offshore workovers when Zone A is depleted.

All six packers run were hydraulic set packers. Five of the six packers were provided with a hold-down feature to prevent communication between zones when subjected to differential pressure below any packer.

A hold-down was not needed on the upper packer.

Quintuple string retrievable hydraulic set packer had already been built and tested. Quintuple packer is a continuation of the retrievable hydraulic set series of packers which have been run in dual, triple, and quadruple string completions.

Basic fact that made feasible a quintuple parallel string completion was the technique of simultaneously running five strings of tubing. As the number of parallel tubing strings run in the same bore hole has increased, difficulty has been experienced in the past, especially in deviated holes, in running and stabbing auxiliary strings in the upper packer.

This undesirable stabbing feature was eliminated by the use of power-actuated multiple string slip-type elevators. A power actuated multiple slip bowl was also manufactured to retain five tubing strings in the rotary table while running the tubing.

Running Packers

To prevent any loss in rig time while running packers and tubing strings, sufficient tubing was tallied for the tubing needed below the quintuple hydraulic set packer. Then, with the tally available, spacing was worked out on paper before the job was begun.

First packer, a retrievable single string hydraulic set packer, was run in the hole. Immediately above the packer a landing nipple and flow coupling were run. Landing nipple will serve as the means to locate and land a plug for blanking off the lower zone when it is depleted at a later date.

Run next in the string was a rubber sleeve abrasion or blast joint to protect tubing opposite the producing zone from sand-laden gas. This can, in effect, sand-blast the tubing, causing holes in the tubing which can in turn cause communication problems between zones.

Then a sliding sleeve was run in the closed position. This sleeve can be opened by wire line operation when it is desired to produce Zone B after Zone A is depleted.

Sufficient tubing was run for correct spacing, and then another packer made up in the No. 1 string.

Immediately below this packer, a criss-cross safety joint was first placed in the string. Safety joint is used to aid, if necessary later, removal and retrieving of the packers.

Same equipment, landing nipple, flow coupling, abrasion joint and sliding sleeve, were run above the second packer. More tubing was run until it was time to put another criss-cross safety joint in the string, followed by the retrievable hydraulic set packer.

Packer is equipped with a hydraulic hold-down to assure that the packer remains set even when subjected to extreme pressure differentials from beneath the packer.

In producing multiple completed wells, quite often one zone is shut-in while another is producing. Thus, differentials occur across the packers used in these installations. When the zone pressure below the dual packer, for example, exceeds zone pressure above the dual packer, hydraulic hold-down buttons move out and engage the casing wall.

Hydraulic hold-down buttons can be actuated by the zone immediately below the dual packer to move out and grip the casing wall. Thus they prevent the packer from unseating.

A hydraulically-operated tubing hoist was used to pick up the tubing strings. A positive-grip lift clamp was used for picking up the tubing.

After a joint of tubing was made up in No. 1 opening of the dual string packer, another joint of tubing was made up in the stinger of No. 2 string. Stinger is connected to the dual string packer by threads.

With both No. 1 and No. 2 tubing strings made up in the dual packer, the slip-type elevators were lowered down over the two strings of tubing and set by the driller. One piece slips were re-

STRING COMPLETION

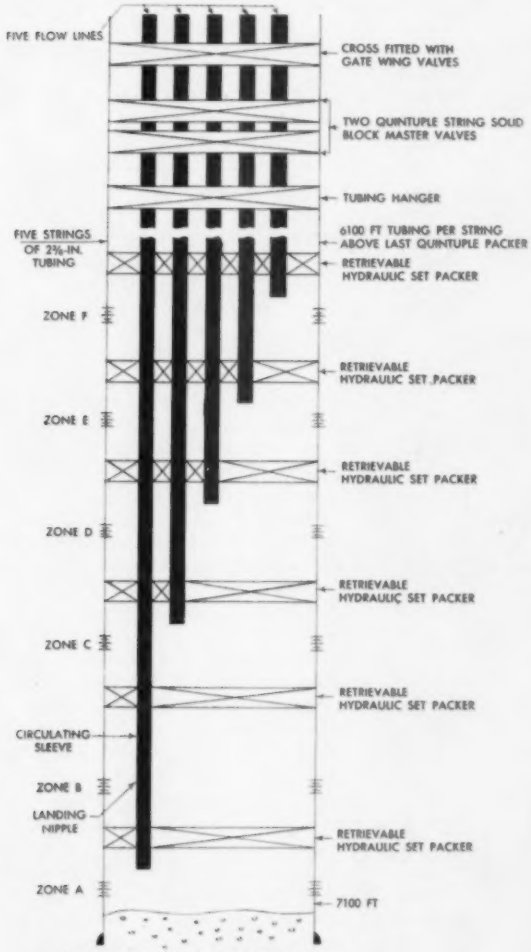
moved from the multiple tubing string bowl and both tubing strings lowered in the hole.

Auxiliary equipment such as landing nipples, flow couplings, abrasion joints, and circulating sleeves were placed in each string and sufficient tubing was run until the spacing was obtained for placing the triple packer in the string.

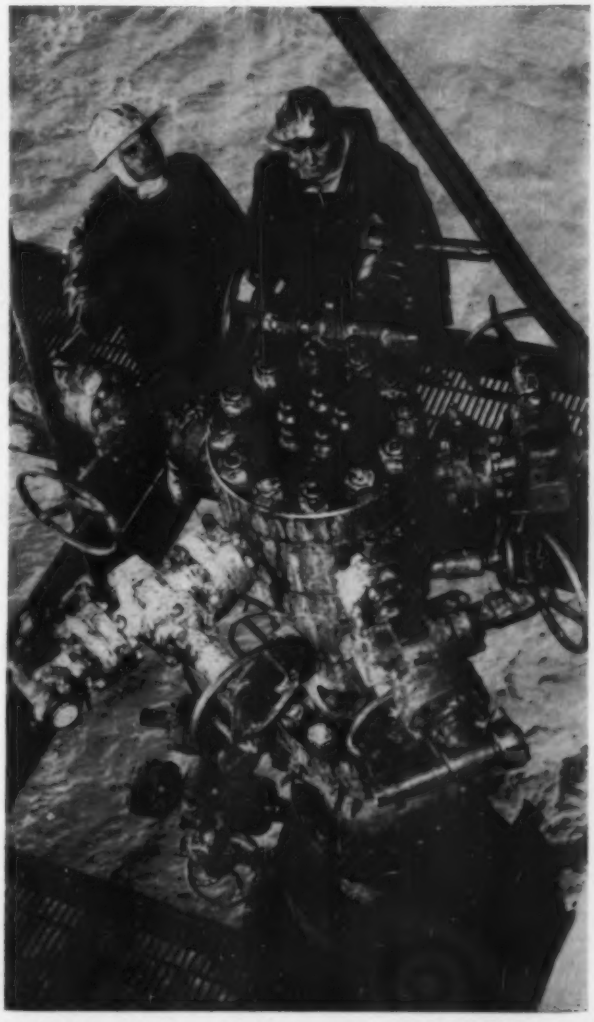
Shear pin safety joint was placed in the No. 2 string. Another safety joint was placed in the primary No. 1 tubing string followed by the triple packer. No. 2 tubing string was connected to No. 2 string mandrel in the packer by an adjustable union.

Adjustable union has a 14-in. stroke which facilitated spacing out No. 2 tubing string between the dual and triple packers, and permitted a feasible means of connecting the string without rotation.

With No. 1 string made up in the triple packer, tubing strings No. 2 and 3 were made up in the stinger of the triple packer. Then three tubing strings were run simultaneously.



SCHEMATIC VIEW SHOWING EQUIPMENT USED IN SINCLAIR'S QUINTUPLE STRING COMPLETION OCS 0439, WELL NO. 6, BLK. 190 FLD., EUGENE ISLAND AREA, OFFSHORE LOUISIANA.
Illustration courtesy Brown Oil Tools, Inc. and Cameron Iron Works



World's first quintuple wellhead is shown near completion of installation on Sinclair well offshore from Louisiana. Waters of the Gulf of Mexico swirl below. Wellhead equipment on the 7981-ft gas well was designed, assembled, and tested in Houston.

(Photo courtesy National Supply Company.)

To facilitate running of the packers, the multiple tubing bowl is a segmented section contained within a housing. With the slip-type elevators set on the three strings, the segmented sections of the multiple tubing bowl were removed and the triple packer lowered in the hole.

Tubing and auxiliary equipment was placed in the individual tubing strings and lowered in the hole to the point where the quadruple string packer was placed in the string. More equipment was run until the quintuple string hydraulic set packer was placed in the string.

When the quintuple packer was lowered into the hole, about 2600 ft of tubing, packers, and related equipment had been run in a total elapsed time of 13½ hours.

All packers had now passed through the rotary table and thus there was no more need for the removable segmented sections of the multiple tubing bowl. Segmented sections of the multiple tubing bowl were removed and the one-piece power-actuated multiple slips were placed in the housing.

Multiple slip segment is an integral piece and can be power-actuated by the driller. This feature permits faster running of the tubing. Driller has readily accessible controls for operating both elevators and slips.

Installing Blowout Preventer

To assure that well was under control while running the five tubing strings, a stripper-type blowout preventer was flanged onto the well. Five individual openings are provided in the stripper rubber. Five tubing strings were inserted through the stripper rubber and the stripper lowered and locked into a housing.

Metal slip segments internally located in the stripper rubber were provided to prevent the tubing from blowing out of the hole, should the well attempt to blow out while running the five strings. Well pressure would force the segments to grip the tubing and prevent tubing movement. Tubing safety valves were on the floor for stabbing into each tubing in the event of emergency.

Running Tubing

About 30,500 ft of 2⅜-in. OD tubing was run in the hole in 42 hours, requiring about 56 hours rig time since the first packer started in the hole. All five tubing strings consisted of 2⅜-in. OD slim joint tubing, except for some 2⅜-in. OD integral joint 8 round thread tubing used in the upper portion of No. 1 string.

All tubing was hydrostatically tested to 6000 psi employing the going-in-the-hole tubing testing method. Entire length of the joint was tested and two hydraulically operated units were used to speed up testing time.

Tubing strings were internally plastic-coated and equipment designed with dual seal assemblies which have no metal inserts to come in contact with coated tubing.

Tubing was made up with hydraulic tubing tongs to assure uniform tubing make-up to the manufacturer's specified torque.

Landing Tubing

Last joint of tubing in each string was chosen so that all five strings would land at the same point and tubing hanger installed.

Hanger consisted of a mother hanger with five openings for individual tubing hangers. Mother hanger was placed on the five tubing strings with the slot opening on the side of hanger facing in the proper direction for landing in the tubing head.

Tubing strings had been properly oriented by aligning No. 1 tubing string when tubing was first run. With the hook locked, tubing strings remained in proper position during running operation.

Individual string tubing hangers were made up on the tubing strings and then landed in the tubing head and hanger was thus properly oriented for installing the Christmas tree. Five joints of tubing were made up in the tubing hangers and the entire hanger assembly landed as one unit.

Installing Christmas Tree

Operator installed a quintuple string solid block Christmas tree. Master valve was flanged into place. Another identical block was landed and flanged on the first block of valves. Thus each zone was equipped with double master valves and gate wing valves.

Circulating Well And Setting Packers

With the tree in place next operation was to displace the mud, replace it with a suitable completion fluid and set the packers. None of the packers was set at this time and all tubing strings were landed by normal tension due to their own weight.

Reverse circulation down the casing annulus and out the No. 5 tubing string displaced the 11.7-lb per gal mud which was replaced by 11.2-lb per gal weighted water solution containing calcium chloride.

When the casing and No. 5 tubing string had been completely displaced and filled with the completion fluid, a plastic setting ball was pumped down the No. 5 tubing string to set the quintuple string packer. With the ball seated on the seat at the lower end of the mandrel for the No. 5 string in the quintuple packer, tubing pressure was increased to 5000 psi to set the packer.

To test packer from the top side, pressure was built up in the casing to 1800 psi.

Pressure was bled off No. 5 tubing string and pressure remained constant in the casing, indicating that the quintuple string hydraulic set packer was set and holding from the top side.

Pump was connected to No. 4 tubing string and mud was displaced from No. 4 string out and around the quadruple string packer and out No. 5 tubing string. This displacement procedure pumped the setting ball to surface, where it was retrieved.

Quintuple string packer was then tested from beneath the packer. Pressure was bled down to 600 psi in the casing and a pressure of 2000 psi applied below the packer. Pressure remained constant at 600 psi in the casing, so the quintuple packer was holding satisfactorily from below the packer.

Plastic setting ball was pumped down No. 4 tubing string and quadruple string packer set and tested in a similar manner as the quintuple packer. Tests both above and below the packer indicated the quadruple string packer was also set and holding satisfactorily.

Displacing, setting, and testing procedures were continued in a like manner until all multiple string packers had been set.

To set the two single string hydraulic set packers, a bronze ball was dropped down the tubing and seated on the shear sleeve below the lowest single packer.

Pressure in No. 1 tubing string was built up to 4000 psi. Shear pins sheared and ball and shear sleeve fell to the bottom of the hole.

Zones were swabbed in and placed on test.

Only difficulty during the entire operation occurred at this point, but it was not connected with running the quintuple strings.

A swab line parted, dropped into one string and could not be retrieved by usual fishing methods. As a result, Sinclair decided to back off the affected string and retrieve it.

With the other strings still in place, the affected string was retrieved, and swab line recovered. Then the string was successfully stabbed back into the remainder of tubing in the hole, even though it was doubtful whether this could be accomplished.

String was put into production almost immediately afterward. ★ ★ ★

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Now you can have *Economy* in a tubing joint... and Hydril Joint advantages, too! Hydril "A-95" *Economy* Joint has adequate tension strength, pressure-sealing strength and torsion strength for all medium-depth completions.

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Helicopter used in Colombian exploration approaches a clearing in the Magdalena River Valley. Special trays attached to the outrigger skids carry the compact seismograph recording equipment.

● UNTIL THE INTRODUCTION of helicopters, the pack mule provided the only successful means of transporting exploration crews and equipment deep into the almost impenetrable jungle regions of Colombia. Although the expense is somewhat greater, helicopters are proving of invaluable aid in this work. Almost everything used can be transported by the helicopter, including the light portable rig used to drill the seismic shot holes. And survey crews can increase their daily spread coverage considerably.

However, because the helicopter operation is relatively expensive, a system has been worked out by one seismograph company* to use helicopters to transport only the specially developed light weight transistorized recorders and related equipment. Mules are then used to transport the portable drilling rig, shooting units, and other heavier equipment.

This system works out very well in that, for every equipment set-up, the items the mules carry usually go to only one or two locations, such as the location to drill the shot hole. On the other hand, the recording amplifiers, recording units, power supply, camera, and jug lines which the helicopter carries are spotted over a much wider area. This permits everything to be set up and ready for the shot recording at about the same time.

New transistorized equipment will permit the helicopter to transport everything needed for one complete recording unit in only one load.

The helicopters are very popular with the crews as it is considerably more pleasant to fly to a new location than to ride the slow and rough-riding mule. And the helicopters are of invaluable use for any emergency. Injured personnel may be rapidly transported to distant hospitals for better treatment. Also, a quick trip can be made to the base camp for any supplies that might suddenly run short, or a malfunctioning piece of equipment can be quickly replaced.

In jungle operations, long straight lanes are chopped clear and used for access roads and shot point locations. Temporary camp sites are set up every few miles along these cleared lanes. Use of the helicopter permits these camp sites to be spaced farther apart, reducing the expense of operations. The crews can also be sure of getting back to the camp every night for good meals and lodging. This can mean a great deal in keeping morale of the men high in these remote areas.

Although the mule is still cheaper to use and important in exploration work, the helicopter is moving in fast to take his place. ★ ★ ★

* Geophysical Service Inc.

aids Colombian exploration

Base camp provides comfortable living facilities for the seismograph crews and the helicopter provides transportation home after the day's work.

Clearing in jungle is located along a lane which is chopped clear and used for access roads and shot point locations.

Helicopter lands to deliver seismograph recording equipment. Mules are used to transport heavier loads, although helicopter can be used.

Compact transistorized equipment permits the helicopter to transport everything needed for one complete recording in a single load.

Shot-hole rig is usually transported by mules, as are shooting units and other heavier equipment. Helicopter can be used if necessary.

Baker's New Snap-Set Duals

–the packers that are bringing single-zone control and simplicity to dual completions

Many operators are coming to feel that the best dual-zone hookup is a modern dual-string hookup. A Baker dual-string completion approaches the control and simplicity (and the flexibility) of a single-zone completion. It is the nearest possible equivalent to two single-zone completions in one well.

What makes this possible? Mainly the development of better upper retrievable packers—Baker's new snap-set duals. They are practical and reliable—and so are the Baker hookups they're used in. Operators all across the country are commenting on their impressive performance.

THE IMPORTANCE OF TWO TUBING STRINGS

Producing through tubing—whether from one zone or two—has its virtues. It protects the casing from corrosion and pressure damage. It encourages easier flow and longer flow, discourages gas separation and loss of natural lift. It makes it easier to run instruments and workover tools, makes artificial lift easier.

It is clear that dual-string production can make the economic success of many wells—provided the hookups are practical. That's where Baker's new dual packers come in.

THE IMPORTANCE OF SIMPLICITY AND FLEXIBILITY

A good dual-string hookup is a simple one. Complexity never had a virtue, never had a payout—especially in a dual completion.

Simplicity is important because the hookup must be reliable and flexible. The key to these things is the upper retrievable packer. That is why Baker has explored every opportunity to simplify the design (see opposite page) of these rugged new dual packers.

A good dual-string hookup is a system—not a random assemblage of parts. This system must satisfy certain requirements. Many of the requirements depend on the upper retrievable packer.

First, both upper and lower packer must pack off and stay packed off. Nothing defeats the economics of a dual completion so readily as a packer that leaks.

Other requirements are equally important. Is it easy to set and unset the upper packer? Is spacing out simple? Can packers be tested before displacement? Can mud be displaced and zones washed while flanged up? Is there provision for simplicity of workover? For artificial lift?

It's all a matter of costs and returns. Baker dual packers were conceived to make dual string completions a paying proposition—and that is what they are doing. With these new packers, dual-zone production has come of age.

RELIABILITY IS BAKER'S STRONG SUIT

Any man who knows the Baker reputation will realize there's a lot of packer and squeeze tool experience behind these new retrievable packers. In fact, Baker's knowledge of these things is unprecedented.

Baker packers have proved themselves in thousands of wells the world over, holding for years, in many cases, against high pressures and withering temperatures. That's a tough proving ground for packing, slips, setting methods, and the like. That is one reason Baker packers are tough and reliable. Reliability is Baker's strong suit.

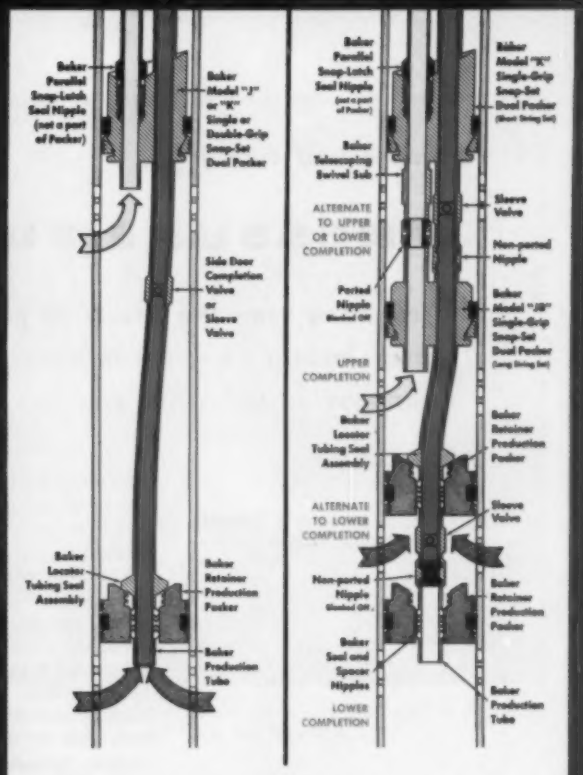
BAKER RETRIEVABLE SNAP-SET DUAL PACKERS

THERE ARE TWO BASIC MODELS. Each comes in a single-grip and a double-grip version. (Double-grip version has hydraulic hold-down buttons that tighten grip on casing when pressure from below increases.)

PICTURED IS MODEL J (Product 756-J) in the single-grip version. Model J is long-string set. You set it by setting down long string against the resistance of the stinger installed in lower retainer packer.

MODEL K ISN'T SHOWN. Model K (Product 756-K) is short-string set. You set it by setting down short string against resistance of long string. This permits either (a) keeping long string in natural tension, or (b) running another retrievable packer below the Model K.

A close look at Baker Dual-String Hookups - and at the Baker packers and accessories that make these hookups simple, flexible, and practical


Baker Parallel Snap-Latch Seal Nipple (not a part of Packer)
Baker Model "J" or "K" Single or Double-Grip Snap-Set Dual Packer
Side Door Completion Valve or Sleeve Valve
Baker Locator Tubing Seal Assembly
Baker Retainer Production Packer
Baker Production Tube
Baker Parallel Snap-Latch Seal Nipple (not a part of Packer)
Baker Telescoping Swivel Sub
ALTERNATE TO UPPER OR LOWER COMPLETION
Sleeve Valve
Non-ported Nipple
Ported Nipple
Baker Model "JB" Single-Grip Snap-Set Dual Packer
UPPER COMPLETION
Baker Locator Tubing Seal Assembly
Baker Retainer Production Packer
ALTERNATE TO LOWER COMPLETION
Sleeve Valve
Non-ported Nipple
Baker Retainer Production Packer
Baker Seal and Spacer Nipples
LOWER COMPLETION
Baker Production Tube

LEFT, STANDARD DUAL STRING HOOKUP. It is simple and basic.

RIGHT, LOW COST MARGINALS. This hookup lets you pick up two marginal zones for little more than cost of two extra packers. Marginals can be produced as alternates to primary zones when allowables are reached.

TWO SIMPLE PACKERS. Basic to a good dual-string hookup are two types of packers. At bottom, to provide the vital separation of zones, a Baker Retainer Production Packer – the most respected retainer packer in use today. At top, to provide the flexibility that makes dual completions practical, a Baker snap-set dual – the new retrievable packer that is proving itself to the most demanding of operators.

UPPER DUAL PACKER: IT'S EASY TO SET AND RELEASE. When you set a Baker Snap-Set Dual Packer there's no ball dropping, no rotation, no pressuring. You set it by setting down minimum weight. To unset, you pick up. It's just that simple. (One model is long-string set, the other is short-string set. See opposite page.)

WHAT SNAP SETTING DOES FOR YOU. It's the snap-setting feature that lets you set and unset the Baker dual packer any number of times – for spacing out, testing packers, displacement, etc. There's nothing final in the latch action – no shear pins, for instance, to burn your bridges and make setting an action from which there's no turning back.

HOW CAN YOU BE SURE SHORT STRING IS IN PACKER? Baker makes a special snap-latch seal nipple that seals off the retrievable short string in sealing bore of upper dual packer. This nipple snaps into packer and holds firm. So to make sure it's seated, just stab in and pull back slightly.

YOU CAN COMPLETE FLANGED UP. Using a side door completion valve, or sleeve valve, or other method, you can displace mud and wash in both zones with well head flanged up. You keep the well under complete control.

WHY BAKER DUAL PACKERS HAVE LARGE BORES. Big bores through upper packer offer a real advantage. Packer bores should be as big as the tubing bores so instruments and workover tools won't hang up. In Baker dual packers the bores are that big – there's no restriction, no necking down. How large are the bores? A dual packer for 7" casing is full-opening for two strings of 2⅜" tubing. What makes this possible is simplicity of design. There are no elaborate seals, valves, or other mechanisms to restrict the packer bores.

HOW SQUEEZE TOOL EXPERIENCE CONTRIBUTED TO THE DESIGN OF SUPERIOR PACKING ELEMENTS. Baker dual packers have three packing elements. They're short and rugged – and the upper and lower elements are harder than the center element. It's a design similar to that used in Baker's high performance retrievable squeeze tool – the Full-Bore Cementer, which has been used in thousands of high pressure cementing, frac, and testing operations. The design accomplishes three things: It offers (a) positive pack-off with (b) minimum set-down weight, and (c) permits the packer to be repositioned or retrieved easily, because it prevents packing element extrusion without resorting to the metallic back-up rings that sometimes defeat retrievability.

WHAT THE PICTURES CAN'T SHOW. The pictures can't show the stored energy in the tubing string and what it does to maintain packoff. Some dual retrievable packers depend on trapped pressure for a static packoff. In Baker's opinion that isn't adequate, and may easily lead to leakage. It fails to compensate for any packing element extrusion that occurs – and there is usually some. The Baker method does compensate. In a Baker dual packer the stored energy in the tubing string (energy due to set-down weight) acts like a spring to keep the packing elements under a dynamic compression.

SLIP DESIGN PROTECTS CASING. The design of the slips and cones in Baker dual packers protects both casing and packer against excessive radial forces. (This also contributes to easy retrievability.)

IT IS READY TO RUN IN. When a Baker dual packer comes to the well, it's ready to run in. Slips, hold-down buttons, inside seals – they've all been tested and checked out at the factory. Their readiness is known.

SOMETHING TO KEEP IN MIND. Parts are always available, and so is service. Baker operates one of the great domestic oil-field service organizations.

SPECIAL FACTS ON PLANNING DUAL STRINGS
The variables of a dual-string hookup can be many. Baker field staffs are especially well prepared to discuss these things. They have all the latest facts and figures on Baker's intensive continuing study of dual completions. Please contact your Baker branch office for information.

BAKER
SNAP-SET DUAL PACKERS

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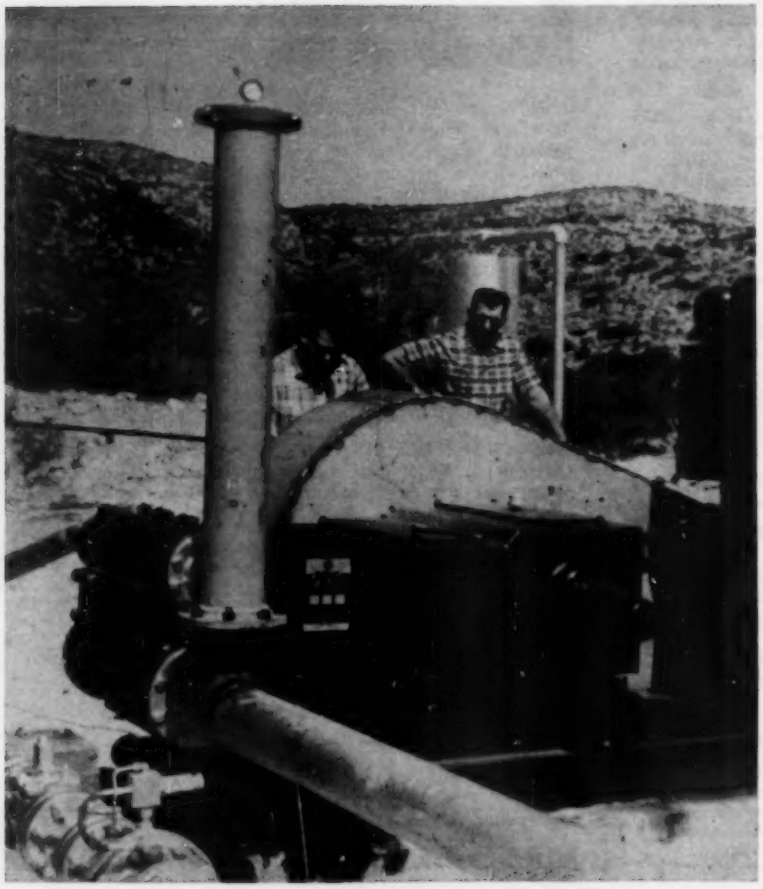
Cause and cure of...

PRESSURE SURGE PROBLEMS

You have seen the effects of pressure surges... often known as water-hammer. Here's what happens... and what you can do about it

EDWARD T. SKINNER
Skinner Brothers Company
Dallas, Texas

PRESSURE SURGE PROBLEMS still are a critical problem in the oil industry. They are most severe where the use of reciprocating pumps are used, such as in pumping wells, pipelines and gathering lines, salt water disposal operations, and waterflood operations. Because of pressure surges, pumps must be operated at reduced pressures and pump speeds. Even so, maintenance costs of systems where surges exist are high due to the damage done from violent pressure surges or the "hammering" of repeating pressure surges from the pumps. But, proper control of surge pressures and forces can result in both lower investment and maintenance costs. Now, let's examine this phenomenon.



Suction stabilizer on a horizontal triplex pump in waterflood operation in West Texas shows good station design, incorporating a minimum of bends into and out of the pump with suction stabilizer installed close to the pump.

Pressure surges are pressure variations caused by changing the velocity of fluid flow. As velocity changes, the fluid either compresses (when speed is reduced) or expands (when speed increases). As a result, compression increases pressure and expansion reduces pressure, causing pressure waves which travel through the fluid with the speed of sound in the fluid.

The pressure of the surge is actually a measure of unit force, that is, a measure of the force on a unit of area, usually one square inch. The problem we are actually concerned with is the resultant surge force which is the surge pressure times the area on which the surge pressure is applied.

The pressure surge phenomenon in pipes can be compared to a train in order to get a mental picture of what happens. When the locomotive slows down, all the cars behind tend to pile up, causing a clatter of the couplers. This is the compression wave of the pressure surge. When the locomotive speeds up, all the cars lag behind until the slack is pulled out of the couplers with another clattering. This is the expansion wave of the pressure surge.

Calculating Pressure Surges

The change of pressure caused by a pressure surge can be calculated as follows:

$$P = (\rho/g)\ (c/144)\ \Delta V$$

where

P = change in pressure, lb per sq in.
ρ = density of the fluid, lb per cu ft
g = acceleration due to gravity, 32.2 ft per sec per sec

Suction and discharge stabilizers installed on a double-acting duplex pump in salt water disposal operation, with stabilizers placed close to pump.

Flow stabilizer installed on a pumping well is designed to remove "knock" from the flow line.

c = velocity of sound in the fluid, ft per sec

ΔV = change of velocity, ft per sec

For water, this expression becomes approximately:

$P = (62.4/32.2)\ (4460/144)\ \Delta V$

$P = 60\ \Delta V$

If the change of velocity is 10 ft per sec, the resulting pressure surge will be $P = (60)\ (10) = 600$ lb per sq in.

From this expression, we can see that the pressure surge will increase with an increase in fluid density, an increase in change of velocity, and an increase in the speed of sound in the fluid. If any of these factors can be reduced, the resulting pressure surge can be reduced. However, for all practical purposes, the density of the fluid and the speed of sound in the fluid are characteristics of the fluid itself and we have little or no control over them. The change of velocity we can control, at least within limits. The least we can do is control the time interval in which the change of velocity takes place. If we try to stop the flow in an instant, we generate a higher pressure than if we stop the fluid over an interval of time.

This too can be pictured by comparing the fluid column to the train. When the locomotive tries to stop too suddenly, the cars behind will catch up very rapidly and may create enough "pressure" to jack-knife the train from the tracks. On the other hand, if the locomotive takes enough time in slowing down, there will be only a very slight chattering of the couplers.

Controlling Pressure Forces

There are several things we can control to control the surge pressure and force in a piping system. These are pipe size, pump speed, length of line, and surge absorbers.

Pipe size. The larger the pipe size, the slower the fluid has to move to get a given quantity of fluid through the line. If we have thus reduced the speed of the fluid in motion, the possible change of velocity is reduced, and so we have reduced the resulting surge pressure and force. But, big pipe costs more than smaller pipe, and this may not be an economical solution to the problem. At best, it cannot eliminate the problem — it can only reduce the amount of surge.

Pump speed. The pump that moves the fluid (unless it is a centrifugal or similar rotary type pump) is constantly starting and stopping the fluid as the plungers or pistons work back and forth. The faster the pump runs, the faster the stopping and starting takes place, the greater will be the change of velocity, and the higher are the resulting surge pressures and forces. If we run the pump slow enough, we can materially reduce the surge problem. However, the slower we run the pump, the less fluid we will move per unit of time. We may have to purchase extra pumps merely because we slow our pumps down too much. This often proves uneconomical also.

Length of line. If we can keep our lines as short as possible, we can reduce surge force even if we cannot reduce surge pressure. Again, let us compare it to a train. A locomotive with only one or two cars can stop much faster than a long train without causing a terrific coupling clatter because, while the change of speed may be the same in both instances, there are not nearly so many couplers involved nor mass behind the "pile up." This consideration must be kept in mind in all installations.

Surge absorbers. We can control surge pressures and forces by other means such as surge towers, relief valves, air chambers and other surge devices. But first, let's see on what theory they are based.

There is an equation known as the equation of state. It is as follows:

$$PV = RT$$

where

P = pressure

V = volume

R = a constant

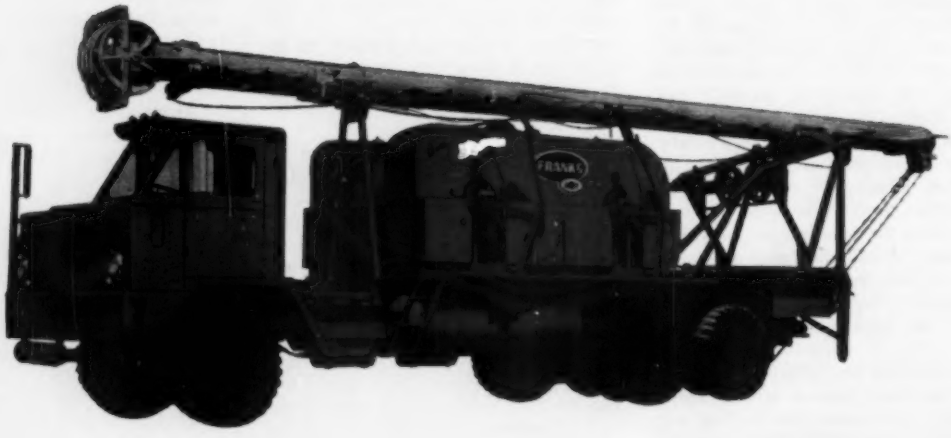
T = temperature measured from absolute zero

This equation says that if the pressure goes up, the volume must go down or the temperature go up, or some combination of both. This also says we can control pressure by controlling volume or temperature.

If we could heat and cool the fluid in our piping system fast enough, we could cool the fluid when the pressure tried to increase or heat the fluid when the pressure decreased and thus maintain a constant pressure. But this is not

FRANKS *Explorer Rocket*

FRANKS *Explorer Cruiser*



OFTEN IMITATED . . . NEVER DUPLICATED

WORTH MORE WHEN YOU BUY 'EM
WORTH MORE WHEN YOU TRADE 'EM

Common sense will tell you that there is a difference in most things despite the tendency to imitate the leader. There's a difference in baseball players . . . in cooks . . . yes, even in oil well servicing units . . . although competitive units are getting to look mighty like the Franks Explorer.

Now, this **difference** is what keeps the Franks Explorer ahead of the pack. It's the difference which makes superintendents prefer Franks units on their jobs. It's the difference you feel in your pocketbook when you trade it in. The higher resale value of Franks Explorers speaks louder of this difference than any words we can dream up.

Ask the man who uses Franks!

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practical, so for most installations our equation of state becomes:

$$PV = \text{constant},$$

and we can control our pressure by controlling the volume. The equation says that if we increase the volume, the pressure will go down, and vice versa. When the air in a tire leaks out, that is, when the volume the air occupies increases, the pressure goes down. All surge relief devices work on the principle of this equation. Now let us look at the various types of devices.

Surge towers are nothing more than risers tall enough that the height of fluid in them maintains the desired pressure in the line. When pressure becomes high enough, fluid runs over the top and keeps the pressure under some predetermined maximum. It is not practical where any appreciable pressure must be maintained or where the fluid is not wastable. It does use the volume in the riser and outside in the atmosphere to control the pressure. Since the surge moves with the speed of sound, the inertia of the fluid in the riser is too great to respond to high frequency surges from pumps and, as a general rule, eliminates the efficient use of this technique.

Relief valves can be used to prevent the pressure from exceeding some predetermined maximum by using the atmosphere as the extra volume. This system necessitates either loss of fluid or complicated plumbing arrangements to recover the overflow. The inertia problem existing with surge towers exists to a certain extent with relief valves as well — the valve cannot work fast enough for high frequency surges.

Air chambers are sections of pipe capped against the atmosphere and partially filled with air or some other gas. When the pressure surge hits, the gas compresses thereby increasing the volume in the piping system available to the fluid. This relieves the excessive pressure caused by the pressure surge. When the fluid system loses pressure, the gas pushes excess fluid back into the system, reducing the system volume and maintaining a relatively constant pressure. Air bottles will do a good job at relatively low frequencies when properly tuned. But the very pressure of the gas causes it to dissolve in the fluid and be washed away in the fluid. As a result, they need constant attention to keep sufficient gas volume present; this often results in high pressure maintenance cost.

Commercial surge absorbers are made with two basic designs: (1) through tools that are a part of the fluid line with all the fluid being pumped passing through the device and (2) appendage tools that are installed in a tee on the fluid line. Neither tool has an advantage over the other by virtue of this design basis. Both can provide the additional volume necessary to properly control the pressure. All designs use a diaphragm to keep the gas from dissolving in the fluid being pumped so that the constant attention of keeping sufficient gas volume in the device is not necessary as in the air chamber.

Some of these devices use perforated mandrels and help dissipate the pressure energy by the pressure drop fluid flow creates in flowing through small holes. However, this also restricts the fluid flow into and out of the gas volume, thereby reducing the sensitivity and efficiency of the device, particularly where high frequency surge problems exist.

Cavitation

There are two aspects of surge problems which warrant special consideration in this discussion. The first is cavitation, or the creation of "bubbles" of fluid vapor in the fluid line. This occurs when the pressure in the fluid drops below the vapor pressure of the fluid. In piping systems, this occurs most generally in the suction line to the pump. From our surge equation, $P = 60V$, we know that if the velocity of the fluid is increased suddenly enough, the pressure can decrease well into the vacuum range. For example, if $\Delta V =$ 1 ft per sec increase, $P = -60$ psi. This is impossible since a perfect vacuum is -15 psi. If the surge tries to reduce the pressure this much, the fluid column will break in two — this is cavitation. It is then that we experience impartial filling of the pump cylinders.

When we get impartial filling of the pump cylinders, we experience extremely violent discharge surges because the pump piston or plunger will be moving at a relatively high rate of speed without pumping until the remaining volume of the cylinder is filled by the piston or plunger. Then the fluid column must have an instantaneous acceleration from standing to flow at the rate of movement of the plunger or piston. If the cylinder only half fills under such conditions, it is very apt to break the pump due to the surge force thus created.

One technique used to prevent cavitation is to use a booster pump to increase suction line pressure. This may or may not help. The booster pump must be capable of pumping at the maximum rate required by the pump plunger at its point of maximum speed. If the booster pump is not sized for this rate, it will actually restrict flow into the pump and reduce pump efficiency; this will also be apt to cause cavitation.

Even assuming the booster pump is of sufficient size, the added pressure increases flow rate since the higher the pressure the faster the flow will be. From our surge equation we can see that this can increase ΔV and increase our surge pressure. This does not mean that the use of booster pumps is bad. It does mean they cannot prevent surges — but, properly sized, they may help reduce cavitation (not prevent it). The booster pump, properly sized, will provide sufficient energy to the fluid to insure filling of the pump provided the surge does not drop line pressure into the vacuum range.

The proper solution for cavitation is proper application of a surge device. If this device is properly sized and installed it can eliminate, for all practical purposes, the surge problem provided sufficient energy is available to push the fluid into the pump. This brings us to the second special consideration.

Fluid Accumulation

In the flow to or from the pump, the fluid is constantly stopping and starting because the pump plungers "push" fluid half the time and "suck" fluid the other half. A properly sized surge device will then become a flow stabilizer to allow the fluid to flow at the average rate required by the pump ignoring the pulsing of the pump.

The surge device does this by accumulation. When the average flow rate into the pump exceeds the instantaneous flow rate, the flow stabilizer takes the excess into the gas volume and expells it when the instantaneous flow rate into the pump exceeds the average flow rate. This gives the pressure stabilization required and materially calms the fluid column. This principle works equally well on suction lines to pumps, discharge lines from pumps, as well as lead lines from pumping wells. To be most efficient, the flow stabilizer needs only to be of sufficient size and installed as close as feasible to the source of the surge — the plunger in the pump. Suction stabilizers should be installed at the suction manifold of the pump. Flow stabilizers should be installed at the discharge manifold of the pump. Flow stabilizers on pumping wells should be installed as close to the pumping tee as practicable.

With a knowledge of the principles outlined in this discussion, you can work understandingly with any pressure surge problem by merely finding the cause of velocity changes in the fluid flow. While this discussion does omit some complex aspects of pressure surges, these omissions do not invalidate the principles stated. The complex aspects augment these principles and are used only where complex harmonic pressure surge conditions exist. ★ ★ ★

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For additional information about why Gray Engineering Design is another step forward in advanced quality control, write today for your copy of the new Gray Catalog.

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DOWELL CUSTOMER GETS

"NEW" WELL FOR PRICE OF FRAC JOB

Engineered fracturing—as practiced by Dowell—can do many things for producers. Treatments can increase production, reduce workover and production costs, improve gas/oil or water/oil ratios, and increase recoverable reserves. Fracturing has even saved valuable wells from abandonment.

A Texas Panhandle producer feels like he got a "new" well for the price of a frac job . . . here's how it happened:

Production had declined to 11 bopd—pumping—from an old well completed into the Cleveland sand. Completion was through perforations from 6420 to 6458 feet. Workover was considered because new offset wells tested 400 bopd on completion.

Dowell engineered a fracturing treatment with the "Frac Guide"*. Waterfrac was selected for efficiency and low cost. 40,000 gallons gelled water and 105,000 pounds sand were used. 70 gallons of Freflo* were used to prevent emulsions, and 100 ball sealers were used to divert part of the treatment into less permeable zones. Injection rate was 65 bpm at 900 to 1400 psi down seven-inch casing.

Following treatment, *production stabilized at 105 bopd flowing.* Payout time for fracture treatment was four months.

DOWELL FRACTURING AND ABRASIJET HELP GET GOOD PRODUCTION FROM "PROBLEM" FIELD

Wells in the Langlie Mattix field of Lea County, New Mexico, are hard to produce. The oil pay of the Seven Rivers formation is tightly sandwiched between water below and gas above. It will not produce satisfactorily without stimulation—yet fracturing usually results in water or gas rather than oil.

Dowell engineers suggested a two-stage treatment that is working extremely well. First, Abrasijet* is used. The jetting tool is set in the middle of the oil zone at about 3585 feet, and the walls of the open hole are jetted with oil and sand. This produces considerable enlargement of the well bore.

Then wells are fractured, using 10,000 gallons lease crude and 10,000 pounds sand. This relatively small treatment is designed to provide the needed stimulation without breaking through to either gas or water.

Success has been outstanding. *The first fifteen wells treated are all producing their allowables; only two are producing appreciable water and none have broken through to gas.*

OPERATOR USES DOWELL FRACTURING TO STRETCH OUT DECLINE CURVE

Wells completed in the 'D' sand of the Southwestern Wayne pool in McClain County, Oklahoma, had not responded well to fracturing. Usual treatments had been 10,000 to 20,000 gallons of refined oil carrying one pound of sand per gallon. Initial production would be satisfactory but production would decline rapidly—frequently approaching pre-treatment levels in less than a month.

Dowell engineered a treatment with the "Frac Guide". Petrojel* was recommended for a well completed through perforations from 6977 to 6994 and from 7062 to 7076 feet. 20,000 gallons gelled crude with F.L.A.* (Fluid Loss Additive) and 46,000 pounds sand were used. 25 ball sealers were injected at mid-treatment. Injection rate was 21 bpm. *Before treatment, production was 10 bopd. Three months later, production had STABILIZED at 30 bopd.*

GOOD GAS/OIL RATIO RESULTS WHEN KANSAS OPERATOR USES DOWELL FRACTURING AND ABRASIJET

Wells completed into the Mississippi Chat of the Spivey-Grabs pool in Harper County, Kansas, have a GOR limit of 3000/1. An operator wanted to fracture to improve production—yet not break through to gas. Abrasijet was used to perforate casing at 4464 feet. Then, following treatment with 500 gallons Mud Acid, well swabbed 12 barrels of oil in seven hours.

After fracturing with water and 3500 pounds sand the well *flowed* 10 boph on a ¼"-choke. *Gas/oil ratio was only 1323/1—exceptionally good for the field.*

Your Dowell engineer can help you select a treatment to solve your well problem. Call him for further information or service. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Argentina, and Venezuela. Dowell, Tulsa 1, Oklahoma.

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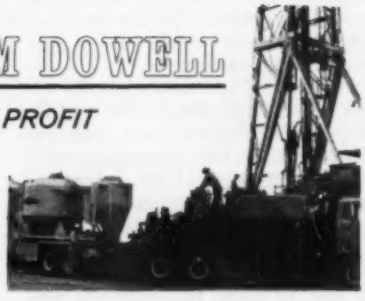
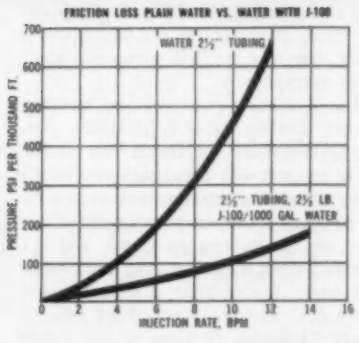




ROCKSHOCK*

This new Dowell service employs glass *implosion* capsules to clean formations or reduce breakdown pressures ahead of fracturing or acidizing treatments. Hydrostatic pressure is used to break the capsules. This action releases powerful pressure waves—to remove scale and other deposits, break emulsion blocks, and to initiate fractures.

FLAC*

This new fluid loss control additive for cement is a major breakthrough in both squeeze and casing cementing techniques. It cuts fluid loss to almost any desired extent without affecting other characteristics excessively. Supplies are limited at present, but operators are invited to familiarize themselves with FLAC so it may be used when it becomes more available.

SLICK WATER (J-100)

This is Dowell's new, improved thickening and friction reducing agent for fresh water. It effectively improves the sand-suspending qualities of water. More important, however, is its ability to reduce friction losses and pump requirements by more than one-half as shown on the graph. The result can be better fracturing at lower cost.

DISSATISFACTION:

A KEY TO PRODUCTION PROGRESS

A Guest Editorial by

Marion H. Stekoll
Stekoll Petroleum Company
Dallas, Texas

DATE: JUNE, 2060. We've discovered oil on Jupiter and sent a superintendent there to supervise the operations. We ask him for daily reports. Subsequently, the reports come back every 12 hours. But, we don't want them every 12 hours . . . just daily. However, our superintendent reports back that a day on Jupiter is only 12 hours long and up there they always do things on a daily basis and the field personnel don't want to change.

Later, we find petroleum on another planet and we send supervisory personnel to handle operations. We ask for daily reports, but they arrive every 48 hours. We direct the supervisor to send them every 24 hours because that's the way we do it here on Earth and it's the only right way of gaging and checking wells. We've done it that way for 50 years, and we want those reports every 24 hours. In spite of the supervisor's protests that they will have to go out to all wells at midnight to follow our instruction, that's the way we want it done . . . every 24 hours.

This hypothetical case illustrates an attitude we have developed during the past 50 years of U. S. dominance in the world petroleum industry. But, whether we realize it or not, our world dominance is gone, now and forever. We now have less than 10 percent of the world's reserves and that will undoubtedly diminish in the future.

We must understand this feeling, not just know it as a statistical fact, in order to comprehend just what we're up against in this country to maintain the position of the U. S. industry. It is not probable that we will find reserves in the U. S. to compete with foreign oil.

Yet there is an answer: it lies with the petroleum engineers.

As near as I can determine, the answer lies nowhere else . . . not with the independent producer, nor with any change in laws. Our greatest potential to do something about the current and future U. S. oil conditions lies in the petroleum engineering group.

There have been few true and basic developments in our industry during the past 30 years. In a pumping well, for instance, we don't really know whether it's pumping right or not. I would say that at least 40 percent of all pumping wells that are pulled in this country are pulled needlessly. The well is pulled, nothing is found "wrong," and everybody is very happy. Then the equipment is run back into the hole, the well is put back to pumping, and nobody worries about it.

And we send a man to a 100-bbl lease every day to gage the tanks. The production may vary ordinarily by no more than 10 percent, but the tanks are still gaged every 24 hours. Why? Because "you just should."

About the only true recent development in the producing industry is the automated tank battery. We are proud of this and go around telling about how much we are now using electronics and automation. Yet I wonder what percent of all the oil produced in the U. S. is gaged by automatic systems, and how much will be gaged automatically in the next 10 years.

Really, what a very small development this is compared to the automatic equipment used in the chemical and many manufacturing industries. For example, a steel block goes in one end of a line and comes out as an engine at the other end. We don't have anything that approaches that, and I think the reason is that we have a very large number of satisfied engineers.

I consider any engineer that is satisfied as destructive because he is not constructive. In an industry like ours that is at a point of crisis, the only thing that will help is the dissatisfied engineer, and one that will stay dissatisfied.

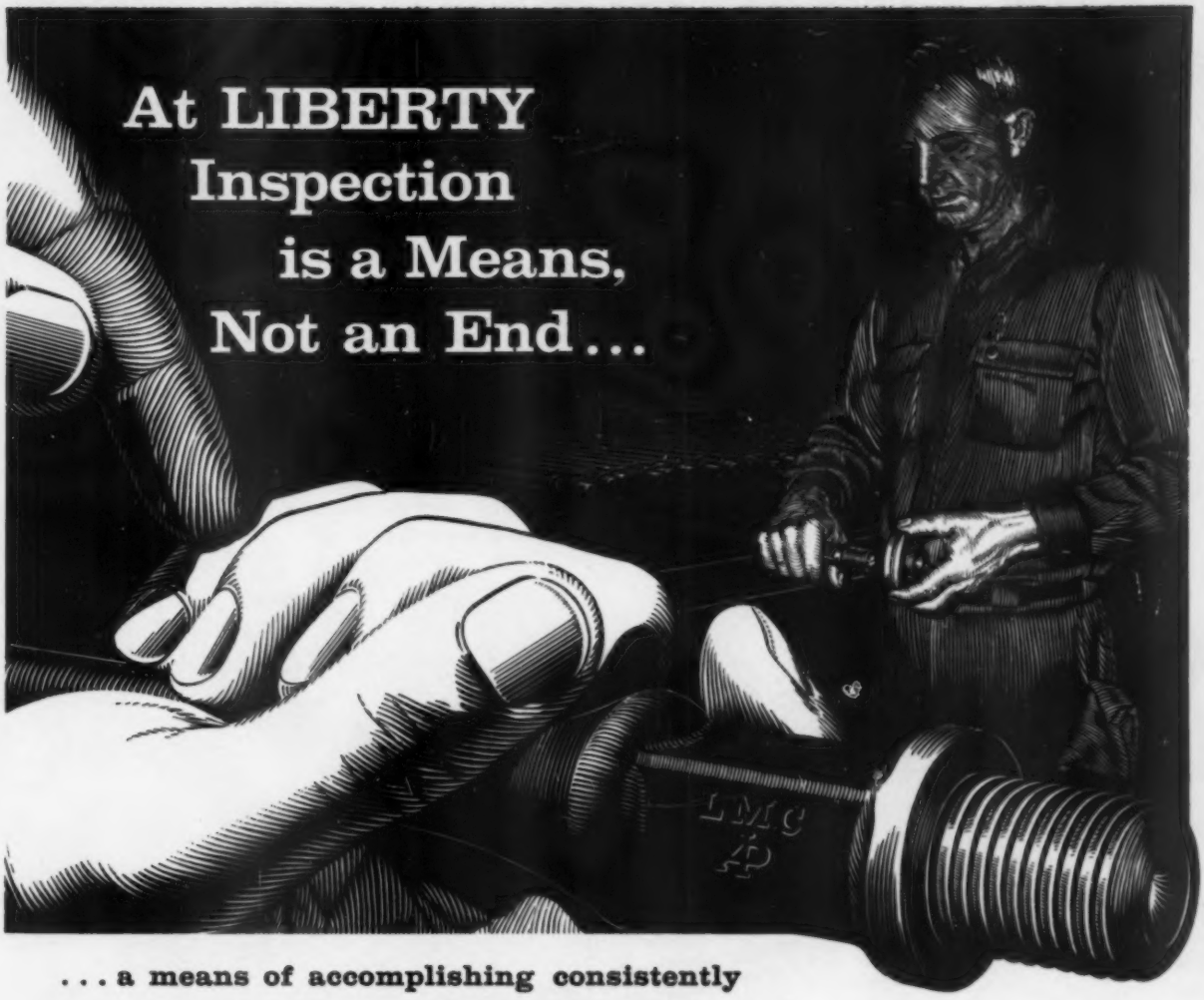
We are never going to have lush times again in the U. S. oil industry and it is time for petroleum engineers in this country to change their attitude and try to find a way to cut costs.

The engineer must cut drilling and operating costs by a third to a half in the next 10 years. It can be done, but obviously not by minor changes in techniques. It will have to be done with some fairly drastic changes.

Too many engineers are satisfied with their present methods of doing things. In being satisfied, they are not offering anything new. But the oil industry must get out of the horse-and-buggy days and there's no one but the engineer to do it.

It is time that the petroleum engineer quits being a follower of men that run oil companies, and demonstrates and proves that the petroleum industry, especially the production and drilling end of it, is really a technical industry and not entirely a hit-and-miss proposition.

The engineer must become a dominant element in the oil industry as he has become in other technical industries. The word "wildcatting" should be applied to ideas. The petroleum engineer is going to have to wildcat with ideas and quit playing it safe as he has in the past. If he will become dissatisfied and unhappy with the way things are done today and be willing to make changes, even if they are mistakes, the U. S. oil industry will have a better future. ★ ★ ★



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Inspection is one of the vital steps in the quality control program at LIBERTY MANUFACTURING COMPANY of Texas, but it is only one phase in a well integrated and co-ordinated operation. The end objective, and one kept constantly in mind during every stage of manufacture, is delivery to the well site of the finest sucker rods that advanced design engineering and metallurgy can produce.

Inspection does play a vital role in maintaining uniformity of product and, consequently, uniformity of performance. That is why LIBERTY exercises 100% inspection of every sucker rod and coupling. Every LIBERTY Sucker Rod is A.P.I. gauged. This is the most rigid inspection in the industry. Producers, from the smallest independent to the largest major, have learned that they can rely on LIBERTY Sucker Rods to perform as specified. For at LIBERTY, the goal is not to produce the most sucker rods in the least time, but to produce the finest sucker rods... regardless of time!

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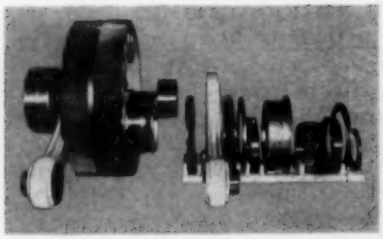

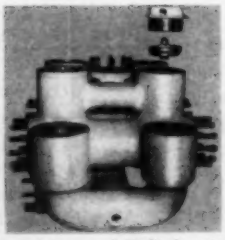

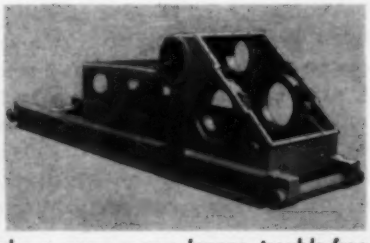

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on the next pages:

Specific reasons for SPANG Extreme Line superiority

16

Specifics prove Spang Extreme Line Casing is superior for deep, high-pressure wells

PRECISION MANUFACTURING FACILITIES
Special precision production equipment has been developed by National Supply to produce Extreme Line Casing. All manufacturing steps —steel selection, piercing, upset forging of ends, thread and seal machining—are carefully controlled.

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Close tolerances of Extreme Line Casing require exacting inspection by highly skilled personnel. Special quality controls, such as thread gauges, microscopic projections, Magnaglo inspections and hydrostatic pressure test, assure perfection of the casing.

UNIQUE DESIGN FEATURES
Positive resistance to leakage is effected by special metal-to-metal seals. A curved surface extending beyond the male threads seats precisely under predetermined pressure into a conical seat at the end of the female threads.

Broad, flat modified Acme threads engage mating members and draw them together in a joint that is shoulder tight.

Pitch and taper of Extreme Line Casing threads permit deeper stabbing and require less make-up than T&C.

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Extreme Line Casing has the mechanical and metallurgical properties to withstand the most severe pressures you encounter. It can be salvaged and re-run repeatedly.

Investigate the many advantages of this superior quality casing for your deep, high-pressure wells. Call the National Supply representative in your area for complete details.

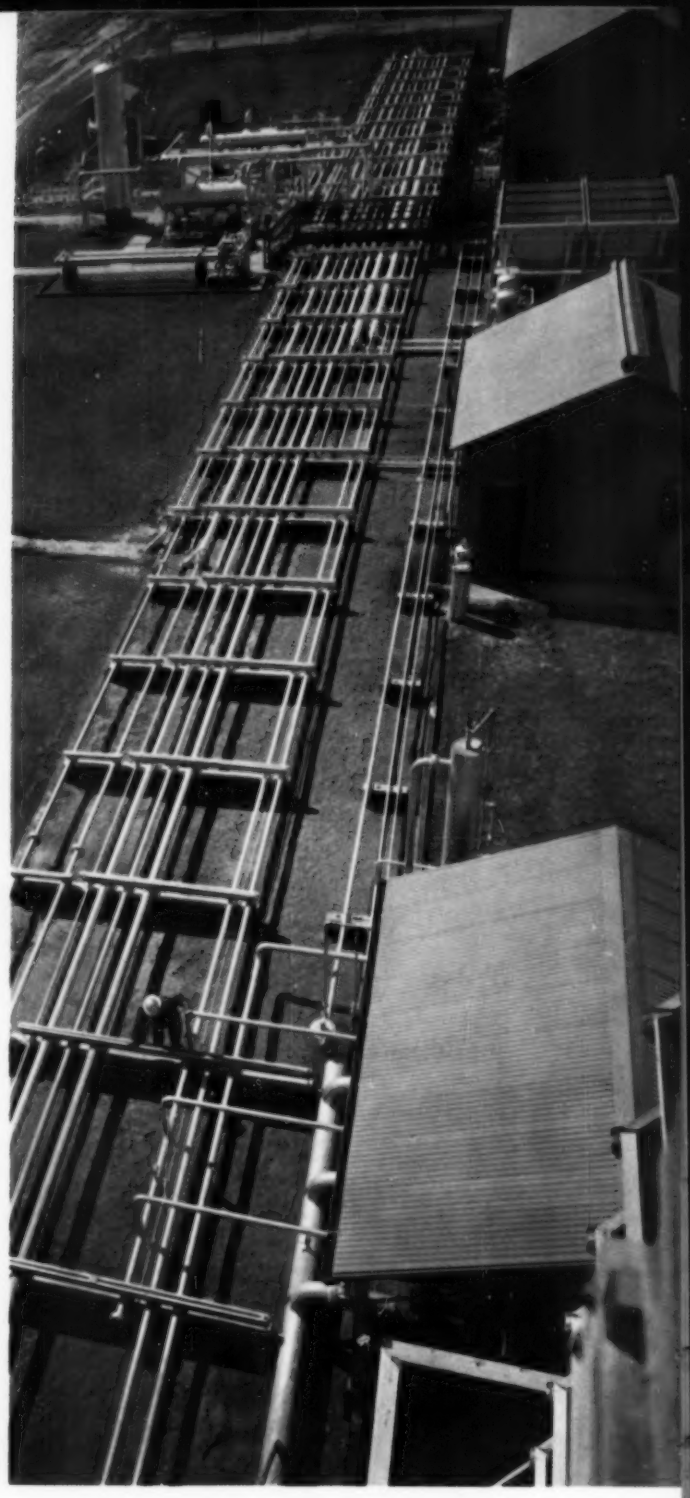
Spang Quality CW steel pipe speeds installation ...it's easy to cut, bend, thread and weld

Special quality Spang CW steel pipe can save you time in laying, gathering and feeding lines.

Spang quality control in every manufacturing step is the answer. Every length of pipe is hydrostatically tested and inspected for thread quality and uniformity. Every length is made of carefully selected steel that meets the toughest standards.

This quality control assures you of pipe that is easy to work, because it is easy to cut, bend, thread and weld.

And most important—there is no premium price for Spang quality. All sizes—plain end or threaded and coupled—are available now. Call your nearby National Supply Store for your next order.



This Spang CW steel pipe is installed at a recycling plant in Texas. The pipe is strong, durable, with smooth finishes—inside and outside.

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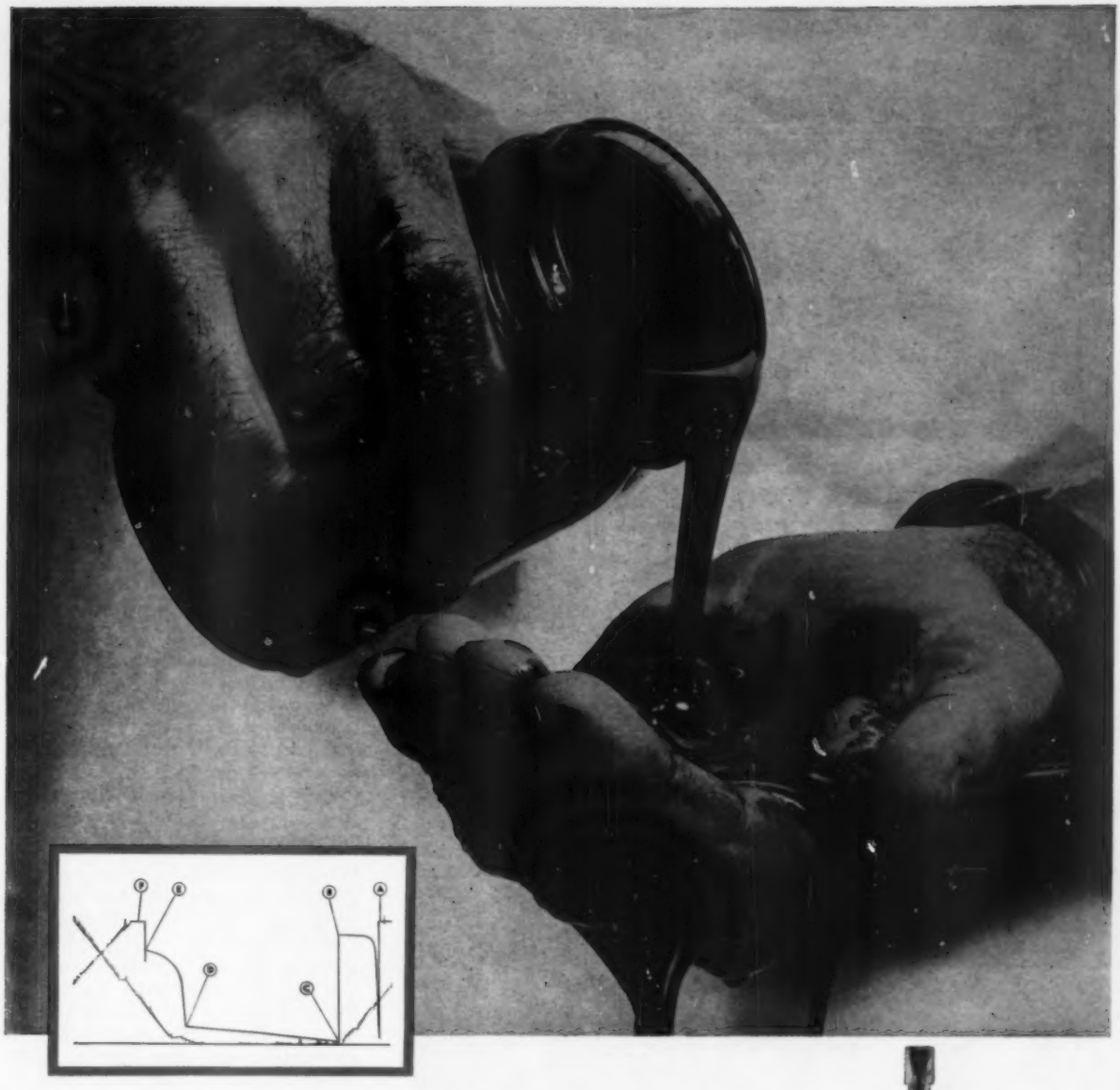

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For a fraction of the cost of a casing string, you get an actual sample of formation fluid and a complete pressure record. With these, fact is positively separated from fiction. Doesn't it make good sense to know if your well will produce before setting casing?

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Next time, and always, call Johnston. You get more from a Johnston Drill Stem test—more experience, the newest and most sensitive recording equipment, accurate evaluation and a complete test record. No other service costs so little for so much.

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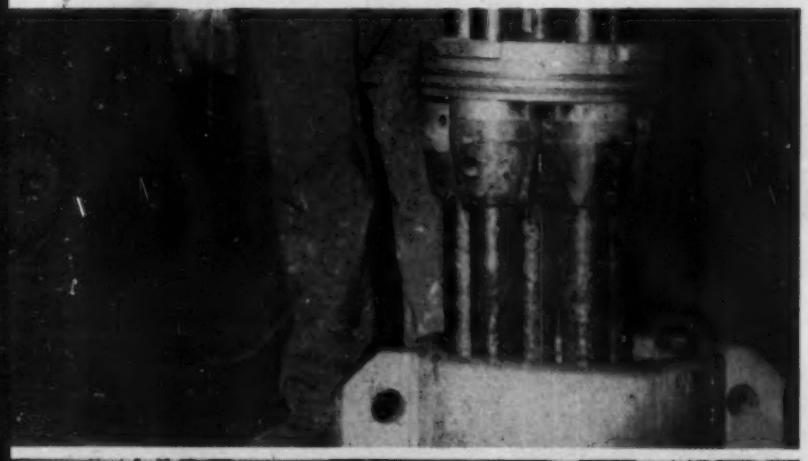

Sinclair Oil and Gas Company recently completed the world's first quintuple string producer. OCS 0439, Well #6, Block 190 field, Eugene Island area, Offshore Louisiana, is the first well in the petroleum industry to produce five zones simultaneously from one well through five strings of production tubing. The participants are: El Paso Natural Gas Company, Peoples Production Company, Sinclair Oil and Gas Company and Sohio Petroleum Company.

When this well was raising questions about equipment, we had the answers on packers. A Brown H-S hydraulically-set retrievable five string packer had already been built and tested—was actually waiting for the well we knew would eventually need it. Our other packers in this completion and the Brown multi-string slips and elevators used to run them have taken many kinks out of the tricky but profitable multi-zone completions. Sinclair's five-string is the latest success in a development program which has made Brown the leader in production tools for over a quarter of a century.

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Self Lubricated Sealed Bearing Increases Bit Life

Field tests with sintered tungsten carbide insert type bits in many areas show footage increases from two to three times that of same type bit without sealed lubricated bearing

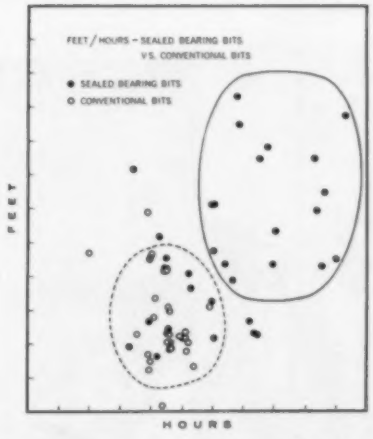
ANOTHER MILESTONE in rock bit research and development was unveiled recently by Hughes Tool Company, Houston. It is the self lubricated sealed bit bearing . . . the culmination of an engineering quest that dates back 30 years when a lubricator sub was first mounted on a simplex bit. The importance of bearing life to the drilling life of a rock bit has long been recognized. And drilling men, manufacturers, and researchers have looked for the answer just as long.

A sealed bearing was an important research project at Hughes Research Laboratories over 12 years ago. But, it was not until the development of the sintered tungsten carbide insert bit in 1951 that further encouragement was given researchers. Through concerted effort in metallurgy, design, and the development of new testing devices, the project received new impetus in 1955.

By the summer of 1959, field and laboratory tests looked good enough to make the first announcement of this breakthrough in August. Last January, the first 8¾-in. sintered tungsten carbide insert type bit with a self lubricated sealed bearing was put on the market. Production was concentrated on the 8¾-in. size, and only in the insert type rock bits.

By early 1961, it is expected that the sealed lubricated bearing will be available on all popular sizes of tungsten carbide insert type bits from 7⅞-in. through 12¼ in.

Not a cure-all. Lyle Payne, assistant vice president of engineering for Hughes Tool, pointed out that the sealed lubricated bearing is not a cure-all for all areas and all types of rock-drilling formations. For example, he stated that certain sections of the Bromide (a very dense quartzite) in Oklahoma are tough on any type of rock bit. In these few very dense sections, there appears to be little difference in the performance of the tungsten carbide insert bit with or without the sealed bearing.



Scatter chart shows performance of 8¾-in. and 7⅞-in. sealed bearing bits (solid circles) as compared with the performance of other tungsten carbide insert type bits without the sealed bearing feature (open circles). Note the pattern created, indicating the increase in footage and hours drilled by the sealed bearing bits.

However, in a large majority of areas, in West Texas-New Mexico, Canada, and even the Rocky Mountains, the tungsten carbide insert bit with the sealed lubricated bearing drilled two and three times the number of feet as the same type bit without the lubricated bearing. There was no noticeable difference in the rate of penetration. In these same areas, this type bit with the sealed bearing drilled up to five times the footage as the conventional mill-cutter type rock bit.

Why not put the sealed self-lubricated bearing on the mill-cutter type rock bit? In general, there is a fairly good balance between cutting structure life and bearing life on this type bit. This has not been the case for the sintered tungsten carbide insert type rock bit. Therefore, it was logical to use this significant bit development where it would mean most to the user. But, Payne pointed out, future research and development will include the sealed bearing on the mill-cutter type rock bit.

What does it cost, and what does it offer the user? So many factors in different areas affect final cost that actual figures won't mean much. W. H. Siems, Hughes' vice president in sales, said that the cost of the tungsten carbide insert type rock bit with the sealed lubricated bearing will be from 25 to 35 percent more than the same type rock bit without the sealed bearing.

Under similar drilling conditions, the insert type bit with the self lubricated sealed bearing will withstand greater loads and higher rotary speeds than other comparable rock bits. This offers promise in those particular areas and formations which respond to weight and speed increases. But, even under similar drilling practices, longer bit life gives two direct cost savings to the user. Longer life at comparable rates of penetration means more footage per bit, and in turn, fewer bits per well. Equally important is a drastic reduction in round trip time.

No change in drilling practice is required. This new bit development is not intended to require special practices for best results. The driller need only use the same proved practices in running and pulling the bit. When to pull this new bit is determined in the same manner as with conventional rock bits. An increase in pipe torque, decrease in penetration rate, experience in the section drilled, and a host of other yardsticks will indicate when to pull the bit.

Research and development continue. Even though the new bit is now on the market, research and field testing and evaluation of results will continue, according to Henry Woods, director of research. And, in production, close supervision of every step in the manufacture is maintained. About 1796 dimensional and other important inspections are made on each 8¾-in. bit. ★

FLY-IN RIG SPEEDS UP BOLIVIAN EXPLORATION

Loffland Brothers de Caracas C.A. puts together a special rig for work in roadless regions of Boliva . . . completely transportable by helicopter in 4000-lb packages

Some of the men interested in the design and operation of the new rig are (left to right): G. H. Ratcliffe, technical representative, Asiatic Petroleum Company (Texas Ltd.), Houston, Texas; Joe Kauffman, transportation superintendent and drilling engineer, Loffland Brothers de Caracas, C.A., Santa Cruz, Bolivia; W. H. Moody, petroleum engineer, California Petroleum Company, Cochabamba, Bolivia; Israel Camacho, honorary consul of Bolivia, Houston, Texas; K. N. Nicolson, drilling engineer, Standard Oil Company of California, San Francisco, California; J. A. Wirtensohn, drilling superintendent, Asiatic Petroleum Company (Texas Ltd.), Houston, Texas; and T. P. McCabe, manager of operations, Loffland Brothers de Caracas, C.A., Santa Cruz, Bolivia.

—Photo courtesy Loffland Brothers.

AN UNUSUAL DRILLING RIG especially designed for use in airborne exploratory drilling operations in Central Bolivia is being assembled in Houston, Texas. The rig will be used in the joint exploration program of Bolivia California Petroleum Company, a subsidiary of Standard Oil Company of California, and Compania Petrolera Boliviana Shell Ltd., one of the Royal Dutch/Shell Group of companies. The rig is being built for Loffland Brothers de Caracas C. A., the drilling contractor for BOLIVICAL and BOLIVISHELL. Loffland is furnishing personnel, rig, camp, transportation, and construction facilities for the drilling operation.

Conditions which warrant a special rig are the difficult accessibility of much of the area, the large distances involved, and the expense of operating a conventional rig with air transport. Much of Central Bolivia is a low plains area subject to seasonal flooding. Terrain ranges from foothills to low swamps and from relatively dry and accessible to usually wet and inaccessible. Few roads exist in this area and much of the exploration program will be conducted 200 to 300 miles from the supply source.

Basic rig specifications were prepared by Standard Oil Company of California in consultation with engineers of Asiatic Petroleum Corporation, another one of the Royal Dutch/Shell Group of companies. Equipment specified is intended to be more economical to transport by air and capable of reducing exploratory drilling costs by efficient application of slim hole practices.

Design Objectives

Objectives considered important in the design of this rig are:

1. Drilling efficiency,
2. Adequate power, flexible control, and standby capacity,
3. Dependability,
4. Portability,
5. Reduction of weight,
6. Ease of rig up.

It is specified that all equipment must be easily disassembled into packages not exceeding 4000 lb for helicopter transport and not exceeding 8 ft by 8 ft by 28 ft for cargo plane transport. The rig is designed to provide capacity for performing the following maximum requirements:

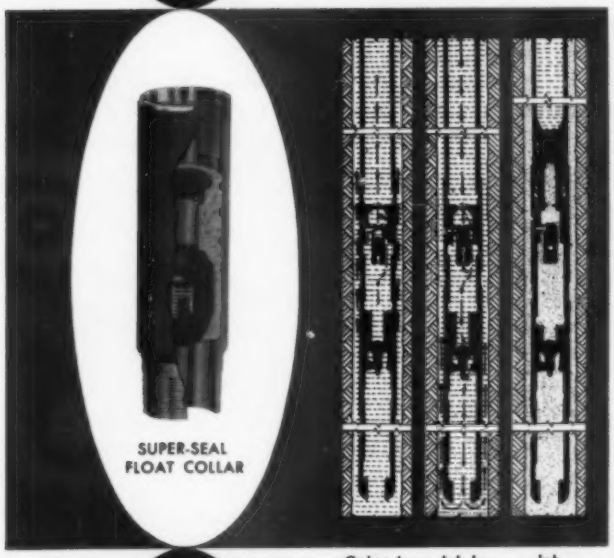
1. Drilling 9⅞-in. hole to 12,000 ft with 4½-in. light weight drill pipe.
2. Drilling 6⅛-in. hole to 15,000

A BETTER WAY TO RUN CASING

FILL IT
WHILE YOU
RUN IT
. . . AUTOMATICALLY

SELF-FILL DIFFERENTIAL COLLAR

Now you can put an end to expensive rig time lost while filling casing from the surface on run-in. How? With this efficient Halliburton Tool Team –


SUPER-SEAL FLOAT COLLAR

Going In Hole | Job In Progress | Job Completed

- Make up your casing string using a Halliburton Cement Guide Shoe on the bottom . . . a Super Seal Float Collar one or more joints above it . . . and a Self-Fill Differential Collar still further up the string.
- The strong, durable Guide Shoe will help direct the casing away from ledges to minimize side-wall caving and aid in passing shoulders and other obstructions in crooked holes.
- The increasing load on the derrick will be greatly lightened by the use of the Float Collar. The efficient Super Seal valve in this tool is designed to seal off further fluid entry above it inside the casing . . . providing the floating effect.
- The Self-Fill Differential Collar is designed to help maintain a nearly balanced fluid head both inside and outside the casing above the Float Collar. A differential valve in this tool admits fluid from the annulus into the string through side ports in the tool, permitting this fluid to automatically fill the casing above the Float Collar. Construction of the valve permits full circulation down through the fill-up collar and casing in the usual manner.
- At the completion of the cementing job, the self-fill differential collar is closed by pump pressure applied after the top cementing plug has landed. If it is necessary to close the fill-up collar prior to this time, a weighted plastic ball (furnished) may be dropped to its seat for the purpose of closing the fluid entry ports.

CONCRETE GUIDE SHOE

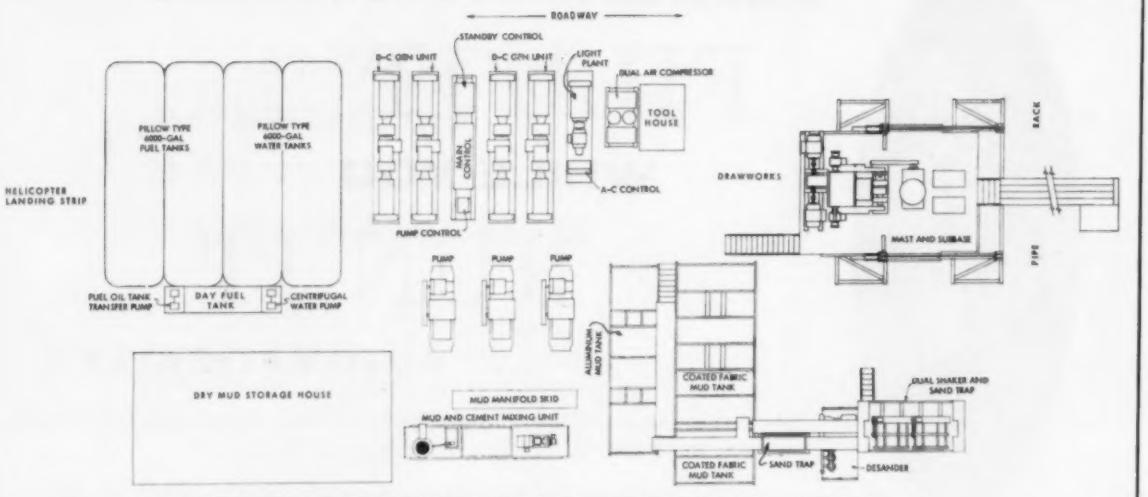
HOWCO WELD Halliburton's popular thread locking compound . . . is excellent for use in making up floating equipment and guiding equipment and casing couplings near the bottom of the string where tight connections are a *must!* It's easier, faster – and actually *stronger than tack welding.*

USE THIS COMBINATION OF HALLIBURTON CEMENTING TOOLS ON YOUR NEXT CASING JOB . . . NO MATTER HOW DEEP THE WELL!

275 SERVICE CENTERS . . . JUST MINUTES AWAY FROM YOUR WELL

HALLIBURTON
CEMENTING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY – DUNCAN, OKLAHOMA



Special airborne rig for Bolivian exploration incorporates such unconventional features as rubberized fabric "pillow" tanks for water and fuel, aluminum mud tanks, rubberized fabric mud tanks, plunger pumps for main rig pumps, and subbase of high-strength aluminum alloy.

ft with a tapered string of 4-in. and 3½-in. light weight drill pipe.

3. Running 7⅝-in. casing to 12,000 ft.
4. Running 4½-in. casing to 15,000 ft.

Rig Power

Diesel-direct current electric power was selected as offering the advantages of flexible control and standby capacity along with portability and ease of rig up. Multiple units of electric generators are provided to drive motors on the rig pumps and drawworks. Four 320-hp generators are installed with controls for an additional unit if required. Each generator is driven by two diesel engines. Generator unit skids will allow moving as a unit or breaking down into three packages for helicopter transport.

Auxiliary a-c power for rig, camp and standby is provided by three 150-kw generators driven by diesel engines.

Drawworks

This unit is designed to handle the loads mentioned above with a minimum hook speed of 75 ft per min with maximum drill pipe load. Drawworks rating of 800 hp was specified and maximum generator engine horsepower demand for drawworks will be approximately 850 hp. An important consideration in this equipment is the requirement for easy disassembly to 4000-lb maximum weight packages.

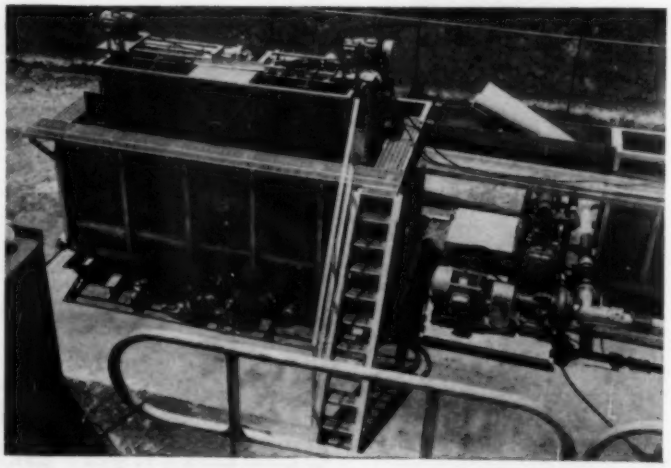
Mast and Subbase

The mast and subbase have a rating of 350,000 lb hook load with concurrent pipe setback load of 150,000 lb. The same considerations of portability and weight and size limitations were applied to the selection of this equipment. The mast furnished for this rig has special alloy steel legs. The subbase is a special design fabricated with a high-strength, corrosion-resistant alloy of aluminum. The subbase was designed utilizing an aluminum-magnesium alloy which exhibited superior corrosion resistance in tests in drilling muds.

Pumps

One of the most unconventional features of the airborne rig is the use of plunger pumps for the main rig pumps. It is anticipated that most of the time the rig will be drilling in 6⅛-in. hole and it will be desirable to maintain jet drilling conditions. It will also be necessary to drill larger hole to lesser depths. Conventional pumps are not designed to provide the low volume and high pressures needed for the first case. Three 4 by 8-in. triplex plunger pumps will be provided for mud pumps. These pumps produce the hydraulic characteristics required and offer the added advantages of light weight and portability. Measures taken to improve the performance of these pumps include a mud desander, suction supercharging pump, and plunger packing lubrication system.

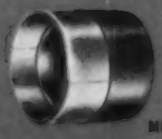
In operation, it is planned to use three pumps in parallel on top hole, two pumps on 9⅞-in. hole, and one pump on 6⅛-in. hole. Controls have



Aluminum shale shaker on left and desander on right provide lightweight mud-system equipment package. —*Photo courtesy Mid-Continent Supply Company.*

*Mission pump parts work together

MISSION VALVES



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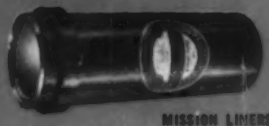

MISSION LINERS

MISSION LINER PACKING

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*SMOOTHLY . . .

From watches to locomotives, mechanical parts work better together when they're designed and built to work together. The same is true for mud pump parts. With the Mission Guarantee you **know** that individually each part—liners, pistons, rods, valves and seats, packing, and springs—will outperform any others. But, when you put them together, allow them to do their best, the savings you get are even greater. And the other side of savings is your profit.

When you put Mission pump parts to work you know you're using the best, that's **guaranteed**; but you also are helping yourself the most, cutting your own costs. Start now to stop the waste of shopping around and standardize on Mission all the way.

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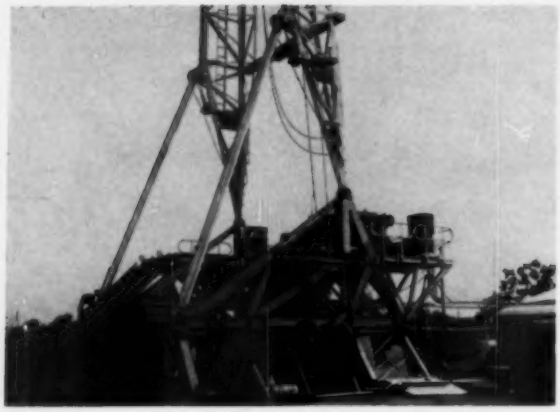
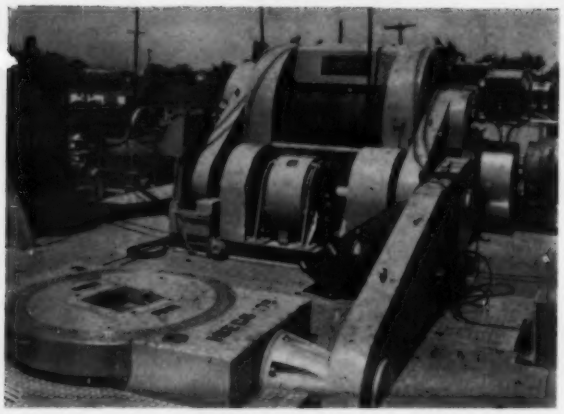


All aluminum substructure supports a mast of special alloy, lightweight steel. —Photo courtesy Ideco, Inc.



800-hp drawworks and rotary table can be broken down into 4000-lb packages for helicopter transport.

been provided for an additional pump if this proves necessary.

Drill Pipe

Light weight drill pipe with light weight tool joints will be used with the rig. 4½-in., 13.75-lb, Grade E drill pipe with welded open-hole tool joints will be used for 9⅞-in. and larger hole. 3½-in., 9.50 lb, Grade E drill pipe with welded open-hole tool joints will be used in 6⅛-in. hole to 10,000 ft. Below 10,000 ft in 6⅛-in. hole, a tapered string of 4-in., 11.85-lb, Grade E, and 3½-in. drill pipe will be used.

Rig Piping and Tankage

The criteria applied to equipment selection have been used throughout the rig piping, mud circulating system, and tankage. Aluminum piping has been used on low pressure service such as water and mud suction. Aluminum mud ditches, tanks, and equipment skids were fabricated.

Fuel and water storage will utilize rubberized fabric tanks and one of the mud storage tanks is aluminum frame with rubberized fabric liner.

Evaluation Equipment

Lightweight portable logging units will be provided. An airborne electrical logging unit will allow making conventional wireline surveys such as electrical logs, acoustic logs, and taking sidewall samples. An especially designed drilling fluid and cuttings analysis unit will accompany the rig. This unit has up-to-date gas chromatographic equipment for use in continuously analyzing the mud effluent for hydrocarbon content. On-location core analysis is also provided.

Camp Facilities

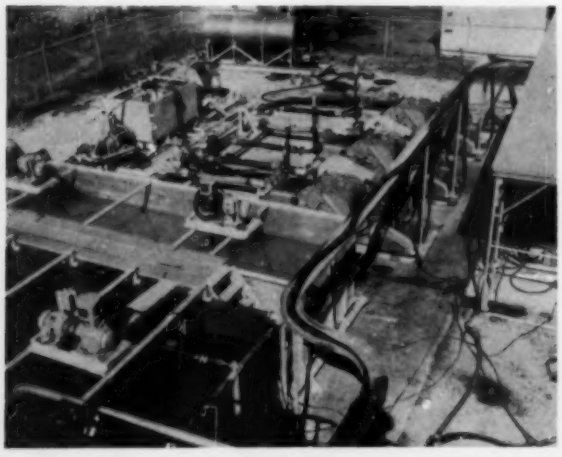
A complete portable camp is furnished with accommodations for 58 men. Living, eating and recreation quarters are air conditioned. These units are designed to disassemble into easily transported packages.

Transportation Equipment

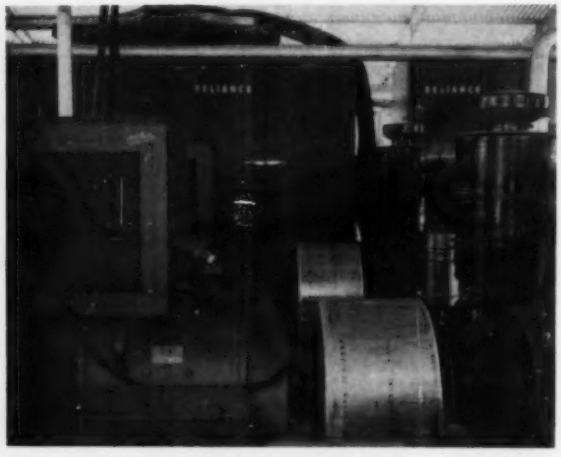
It is planned to transport the rig and supplies usually by air. If conditions at the drilling sites permit, air strips will be built and transport planes used to move the equipment and supplies. Two C-82 planes will be used on the initial rig up. If construction of an air strip is impractical at some location, helicopters will be used from the closest air strip to the location.

Handling of equipment and supplies from plane to rig site will be by tractor with tail boom and forklift trucks. Supply center for this airborne operation will be the Santa Cruz Airport.

The Bolivia airborne rig is one of the most compact and portable rigs of this capacity assembled to date. The weight of the complete drilling rig less pipe, supplies, and camp is under 400,000 lb, or about half that of a comparable horsepower conventional rig. This weight saving has been accomplished without sacrificing rig efficiency. The complete rig including all accessories approximates an investment of $1,250,000, which is about the cost of a comparable conventional rig. ★ ★ ★



Triplex plunger pumps are used for main rig pumps. Tank in foreground is of coated fabric while the second tank is of aluminum.



Rig power comes from diesel engine-direct current generators. Four 320-hp generators are installed with controls for a fifth if required.

SHAFFER

Develops Amazing New Lightweight BLOWOUT PREVENTERS *for Bolivian Airborne Operations*

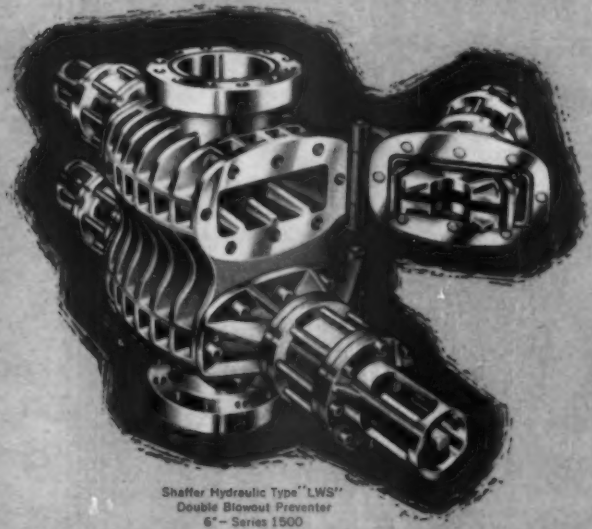
A joint venture of Bolivia California Petroleum Company, a subsidiary of Standard Oil Company of California, and Compania Petrolera Boliviana Shell, Ltd., one of the Royal Dutch-Shell group of companies, formed to carry out an extensive exploration program in the interior of Bolivia, South America, has attracted widespread interest because of the unique manner in which the program is to be developed.

A complete drilling rig—especially-designed for *airborne* exploratory drilling operations—has been built for Loffland Brothers de Caracas, C. A., the drilling contractor who will supply personnel, rig, camp, transportation and construction facilities for the program.

The airborne nature of the operations was decided upon only after careful evaluations to determine the most efficient and economical method of reaching the proposed development area. Roads are virtually non-existent and the area is subject to seasonal flooding that further complicates operations.

Lightweight, Easily-Transported Units

Key to the airborne program has been breaking the normal rig components down into easily-transported "packages"



Shaffer Hydraulic Type "LWS" Double Blowout Preventer 6"—Series 1500

that weigh no more than 4000 pounds each (for helicopter transport) and are no larger than 8′ x 8′ x 28′ (for cargo plane handling).

To avoid complex assembly problems at the rig-site, it was decided that blowout prevention equipment should be transportable as a complete unit, if possible—an assignment that posed complex problems because normally-used blowout preventers with the required pressure rating weigh some 5700 pounds per unit, well above the 4000-pound weight limitation.

It was Shaffer—already experienced in the field of lightweight pressure control equipment through development of its Type "LWS" Blowout Preventers—that came up with the solution...

▶ **A new 6"—Series 1500 Shaffer Type "LWS" *Double* Blowout Preventer unit with 7-1/16" Bore and 5000 PSI *Working* Pressure (10,000 PSI *Test* Pressure) that weighs only 2610 pounds, complete!**

This Preventer has all the features and pressure-handling abilities of equipment weighing over 5700 pounds—yet weighs *less than half as much!*

▶ **Another Shaffer Type "LWS" *Single* Blowout Preventer developed for this project (a 10"—Series 900 Gate) has an 11" Bore, a 3000 PSI *Working* Pressure (6000 PSI *Test* Pressure)—all with a *total* weight of *2100* pounds (compared with the almost 4000 pound weight of comparable equipment heretofore available)!**

Full Range of Features

These new Shaffer developments are, in no sense, "stripped down" versions of heavier equipment. They are a continuation of the Shaffer program of developing lightweight, high-pressure Blowout Preventers and include all the well-known Shaffer advancements such as **"Swinging END-Opening" Doors** for quick, easy ram changes... **Positive "In-Line" Ram and Piston Design** that eliminates yokes, levers and other complex assemblies... **Completely Enclosed Design** with no exposed operating parts... and many other features found only in Shaffer Preventers.

Important
Transportation Savings!

If your drilling operations involve considerable transportation of equipment, it will pay you to investigate these new Shaffer Type "LWS" Preventers for *your* operations. In many cases, savings in transportation cost *alone* will more than pay the moderate cost of equipment!

See your nearest Shaffer representative for complete details on Shaffer's new Type "LWS" Preventers. Or write direct!

QUICK FACTS on New Shaffer Type "LWS" Units

API Size	Bore	Working Pressure	Test Pressure	Weight, Complete
6"—Series 1500 "Double" Gate	7 1/16"	5,000 PSI	10,000 PSI	2,610 lbs.*
10"—Series 900 "Single" Gate	11"	3,000 PSI	6,000 PSI	2,100 lbs.**

***A 55% saving in weight,** compared with normally-used equipment.
****A 46% saving in weight,** compared with normally-used equipment.

The new Shaffer Type "LWS" Preventers are available with Studded Flanges or Bolted Flanges... or with Hubs for Clamp-Ring Connections. They are also available with a wide selection of outlets!

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See why ALCOA ALUMINUM makes a good design habit

Requirement: strength without unnecessary weight plus superior corrosion resistance for world's first aluminum fly-in rig

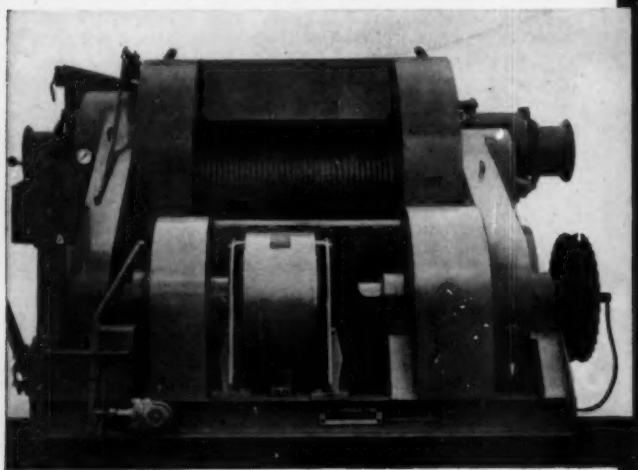
Key to good design: aluminum magnesium alloy 5456 developed by Alcoa

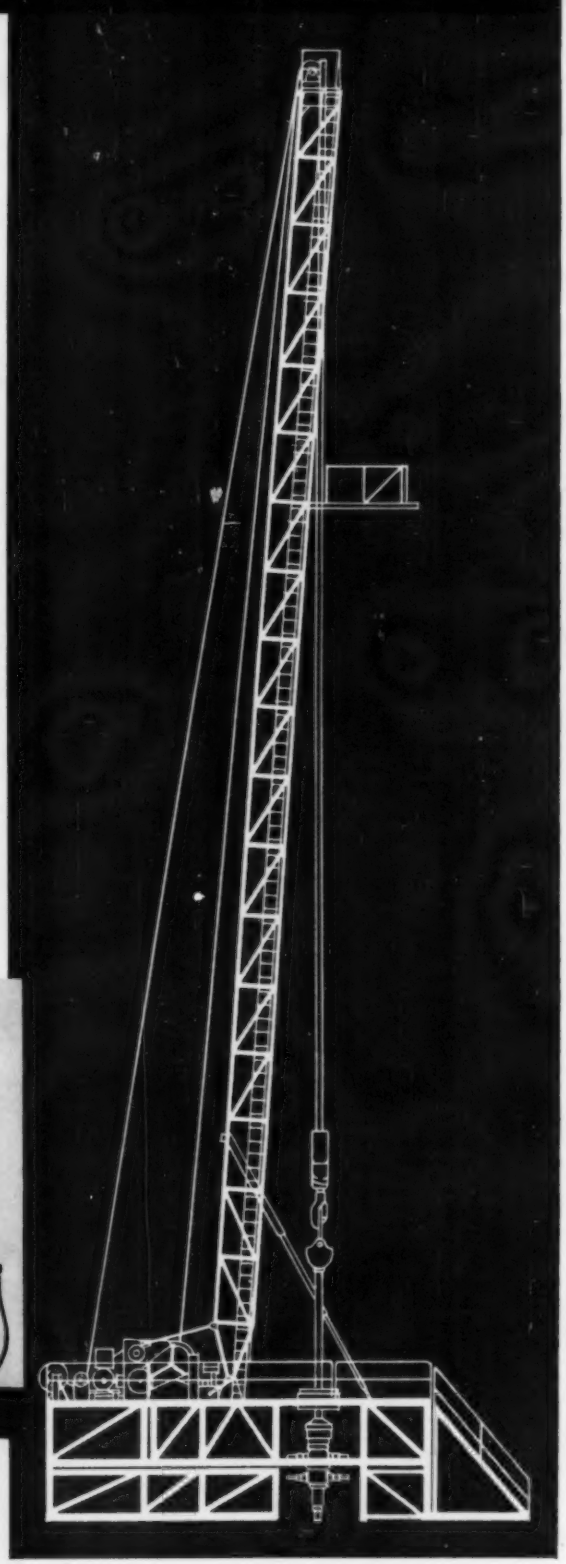
With tests in actual drilling muds, ALCOA engineers proved the superior corrosion resistance of aluminum magnesium alloy 5456 for use in the world's first aluminum fly-in drilling rig. And the excellent strength-weight ratio of this ALCOA®-developed alloy made it perfect for use in the subbase of a special Wagner Morehouse, Inc. draw works that forms the heart of the new rig.

The new rig makes extensive use of the light, strong, corrosion-resistant ALCOA-developed alloy throughout. The substructure is fabricated of aluminum structural members. A fabric mud tank employs an aluminum support frame. The suction tank and suction manifolding in the mud system are aluminum. And aluminum is used for a special shale shaker support and desanding ditch.

The new rig breaks down into 4,000-lb packages for easy helicopter transport. It will be used in hard-to-reach Central Bolivia—in a joint exploration program for Bolivia California Petroleum Co., a subsidiary of the Standard Oil Co. of California, and Compania Petrolera Boliviana Shell, Ltd., one of the Royal Dutch Shell group of companies. Loffland Brothers de Caracas C.A. is the drilling contractor.

Here you see how ALCOA engineers apply over 40 years of petroleum experience to make aluminum the good design habit for the petroleum industry. ALCOA knows aluminum and knows oil and knows how you can put the two together for more profitable operation. Our file of process industries literature will suggest many ways aluminum can serve you. To get it, write ALUMINUM COMPANY OF AMERICA, 881-F Alcoa Building, Pittsburgh 19, Pa. World-wide sales through ALCOA INTERNATIONAL, INC., 230 Park Avenue, New York 17, N.Y.





ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

We'll save $1,600.00 on this workover by using

OTIS TUBING SERVICE

...here's how!

We've got a 6,000-foot dual-producer here that is either leaking around the packer or has a hole in the tubing. At least something went wrong because we had a sudden pressure drop on the lower zone and an increase in pressure on the upper zone. In either event, we're going to have to pull the tubing. And, since we rely on Otis for help on almost all our downwell problems — such as completion techniques and equipment, sub-surface flow control, etc.— we naturally called them in on this job.

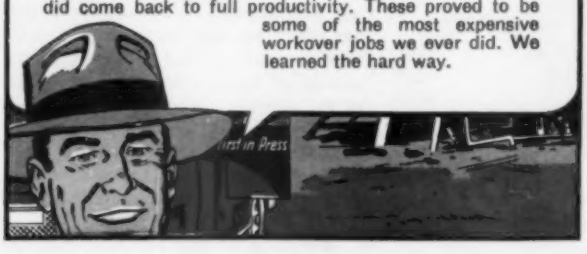
Otis' charges to round-trip the tubing under pressure — this means without killing the well with mud — will figure about $2,800.00, excluding rig costs.

6...12 hour days
or 72 hours as follows:
The first 40 hours...$1600.00
32 hours at 30.00 an hour..960.00
Mileage charges are
80 miles at 75¢ per mile...60.00
Wire line work to plug
tubing and remove plug...170.00
$2,790.00

By way of comparison, our district production superintendent's office estimates it would cost around $4,400.00 to kill the well with mud — exclusive of rig costs. These figures are based upon completing the job without running into trouble, of course.

Oil base mud.....$2200.00
Pump truck to kill well..580.00
Steel mud pits.....100.00
Reserve pits.....100.00
Swabbing.....200.00
Extra mixing and pump
time to handle
oil base mud.....1200.00
$4,380.00

Besides the initial savings we'll make by using Otis Tubing Service, we're eliminating the possibility of fouling up the producing formations with mud. On a few occasions, we killed a well because we thought it would reduce our workover expenses — but by the time we got through cleaning up the formations to bring production back, our costs had skyrocketed. One or two times the well never did come back to full productivity. These proved to be some of the most expensive workover jobs we ever did. We learned the hard way.



When Otis pulls and snubs pipe under pressure they furnish all the special tools, equipment, and trained personnel to do the job. Once they rig up their control heads, snubbers, and lubricator, they set a plug below the packer or in the bottom joint of the tubing and start coming out of the hole with the pipe. Their crews are fast and efficient, and pulling tubing under pressure is no strain the way Otis does it. So, naturally we use Otis Tubing Service all the time. We've found we can save both time and money the Otis way.

If you haven't been using Otis regularly I suggest you contact their nearest office today. Remember—when a workover is in order and pressure presents a problem —

don't kill your well....
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Part 2

Simplified Log Interpretation

Simplified calculation charts facilitate interpretation of induction-FoRxo and guard-FoRxo logs

Terry Walker, *Chief Formation Evaluation Engineer, Welex, Inc., Houston, Texas*

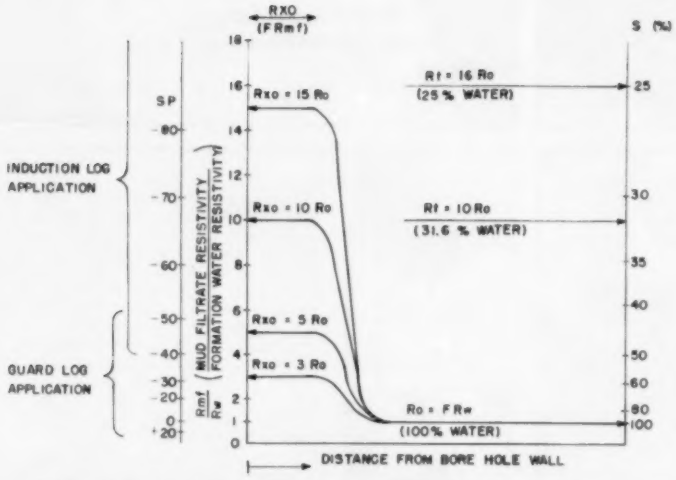


FIG. 1. Effects of Rmf/Rw ratio on resistivity changes with invasion are shown for any porous and permeable zone.

More To Come . . . Part 1 *of this three-part series was printed in last month's issue and discussed the means of simplifying the proper choices of logging tools.*

Part 3 *will discuss applications of the radioactive logging device in radiation induction logging.*

AMONG THE MAJOR PROBLEMS facing the log analyst today are thin beds, zones of widely varying porosity, and a wide range of formation water resistivity. As a result, quantitative log analysis demands much more detailed measurements of the formation characteristics. In addition, the log analyst must understand the effect of these conditions on the various logging devices available. In many areas accurate results will depend upon an understanding of what section of formation the particular device is responding to at a given point. Also, in some areas it will be of considerable advantage to coordinate the logging program and mud program to best meet the conditions expected and give maximum information from the logs.

Induction Log

The physical principles of the induction tool were discussed in more detail in Part 1, but in general this tool is most affected by the lowest resistivity within its zone of influence. This lowest resistivity can be either shales surrounding the bed of interest, shale laminations within the bed, streaks of high porosity where the average is much lower, or a low resistivity invaded zone compared to Rt.

Where low resistivity shales surround the bed of interest, the induction log will give a value close to Rt for a bed 5½ to 6 ft thick or greater. Shale breaks within a bed tend to make the induction tool "see" the zone as a series of thin beds so that bed thickness corrections must be applied qualitatively in many cases because of complex bedding. Where the porous zones of interest are surrounded by dense high resistivity material, the induction log will give a value close to Rt for a zone 3½ ft thick or greater, the higher resistivity material having little effect on the tool.

In addition, streaks of high porosity every few feet in a zone of lower average porosity will have a disproportionate effect, so that the reading is more representative of the resistivity in the streaks of higher porosity than in that of the average. Saturation calculations in this case using average porosity will result in water saturation values that are too high in productive zones, such as is often the case in the Panhandle area of Texas, Oklahoma and Kansas.

Referring to Fig. 1, whenever the

CAMERON TYPE "F" GATE VALVES GIVE MORE SERVICE FOR LESS MONEY

THIS IS THE REASON –

Cameron Type "F" Gate Valves for API service have reduced operating cycle costs to the lowest of any valve in similar service.

HERE'S HOW –

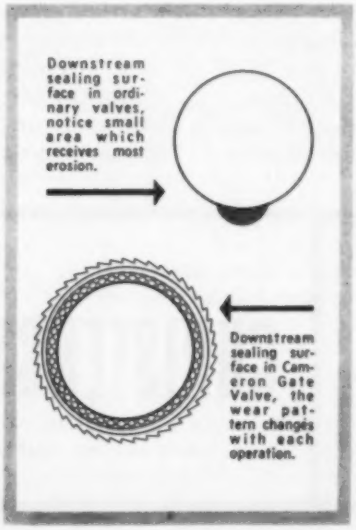
The rotating seat design found only in Cameron Type "F" Gate Valves exposes a new sealing pattern each time the valve is operated. Old design concepts are based on wedge fits to increase gate or plug contact pressure, viscous lubricants to bridge abrasions and reduce inherent friction, soft seals, or combinations of these conventional solutions to a tough problem. After extended tests and evaluation of every contemporary valve for API service, a summary revealed that all valves had one common characteristic. The down stream seat showed the most wear–maximum erosion always occurred in the same point–where pressure was first released in opening or where pressure was finally pinched off in closing.

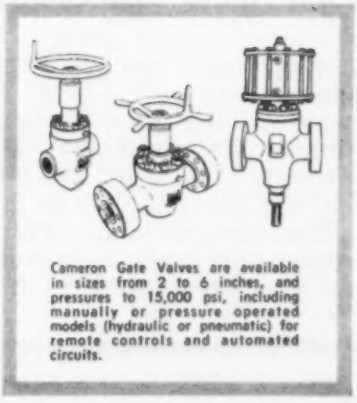
Then a new idea was conceived. Rotating the seat a fraction of a turn each time the valve was opened and closed would present a new surface at the critical point of greatest wear. This principle is the central feature of the Cameron Type "F" Gate Valve.

WHAT ABOUT COST?

All marketable valves when purchased must hold and release pressure. But purchase price does not represent total cost to use a valve. To purchase price must be added operating cost (continuous lubrication, frequent and difficult repair, slow operation) for the useable life of the valve. Divide this total by the number of times the valve is operated and you have a true picture of the original purchase. Actually you are buying operating cycles.

If you want the most operating cycles without maintenance–the lowest cost per cycle during the entire life of the valve no matter how tough the service, try Cameron Type "F" Gate Valves.


Downstream sealing surface in ordinary valves, notice small area which receives most erosion.
Downstream sealing surface in Cameron Gate Valve, the wear pattern changes with each operation.



Cameron Gate Valves are available in sizes from 2 to 6 inches, and pressures to 15,000 psi, including manually or pressure operated models (hydraulic or pneumatic) for remote controls and automated circuits.

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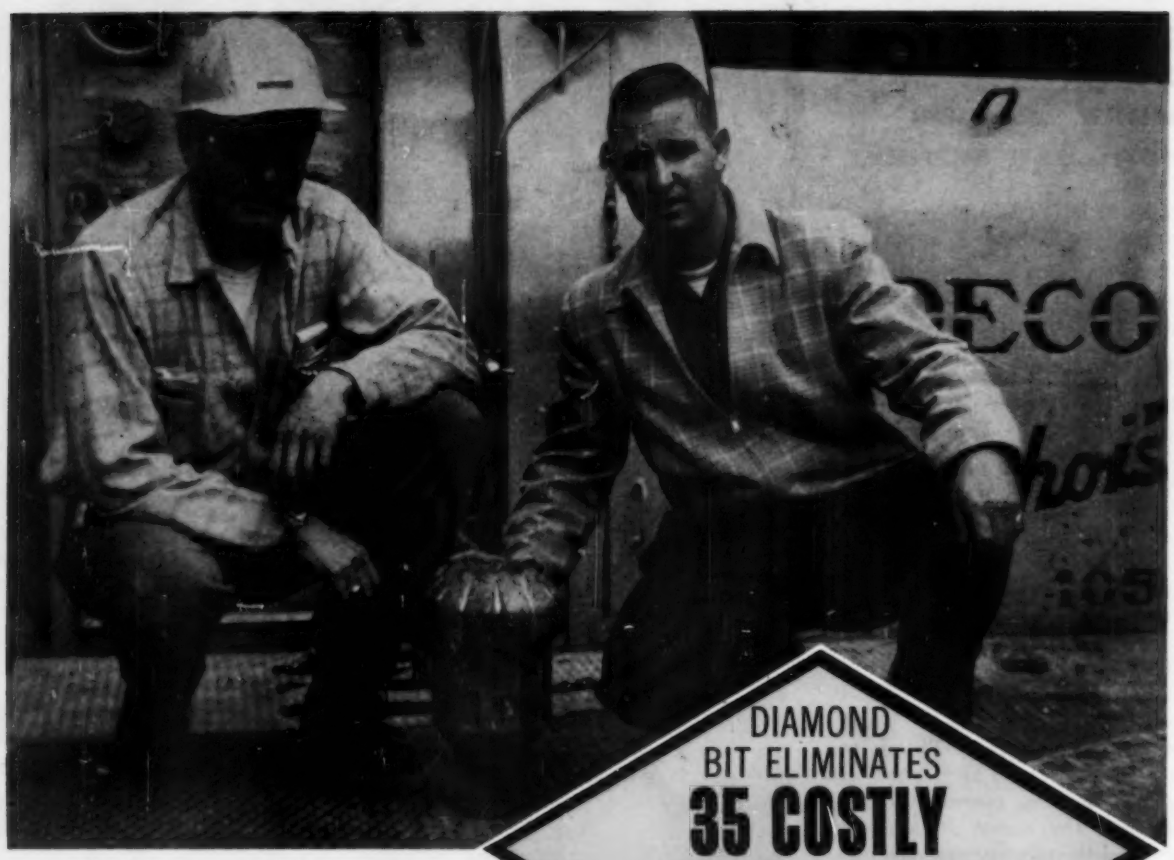
Export Office: 7912 Empire State Bldg., New York City. In England: Cameron Iron Works Ltd., 76 Grosvenor St., London W. 1 England.



DIAMOND
BIT ELIMINATES
35 COSTLY ROUND TRIPS

Christensen Diamond Drilling Bit sets endurance record of 28 rotating days on bottom

The new record was set by a major oil company using an 8-11/32" Christensen diamond drilling bit in Natrona County, Wyoming. After 28 days rotating on bottom the bit was pulled at approximately 16,000 feet and found to be in fair condition. The operating company estimated that 35 round trips and 35 conventional bits would have been needed to drill the same intervals and that the diamond bit saved 18 days.

The bit operated under 10,000 to 16,000 pounds of weight at 53 to 57 R.P.M. The drill string consisted of 4-1/2" drill pipe, nine 7" collars with a set of jars. A second diamond bit had no trouble reaching bottom and ran for 16 rotating days, also surpassing the old 13 day record for the area.

For "Less Cost Per Foot" drilling, contact Christensen Diamond Products Company for information about its complete line of diamond bits and core barrels.

"Less cost per foot."

CHRISTENSEN DIAMOND PRODUCTS

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P. O. BOX 387 SALT LAKE CITY, UTAH

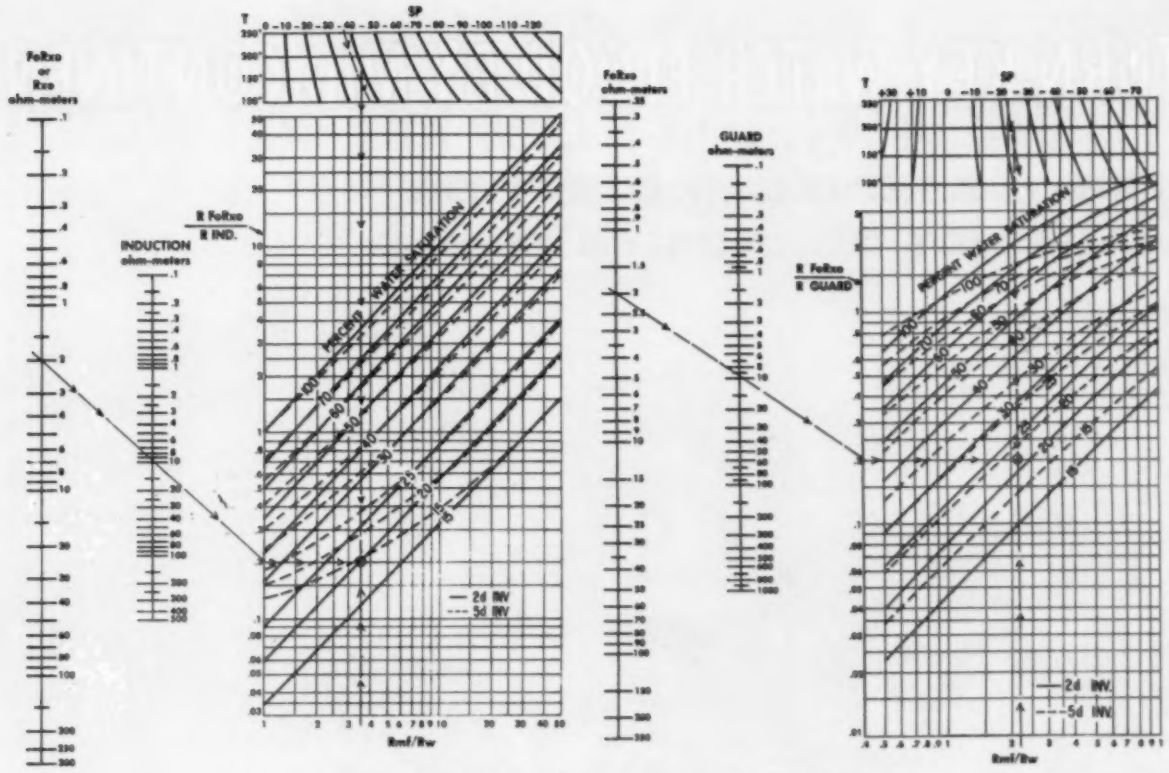


FIG. 2. (left) and FIG. 3. (right) are simplified saturation charts used for calculation with induction logs and guard logs, respectively.

Rmf/Rw ratio is low, Rxo (and Ri) will be near the same value as Ro, so that in a water zone the induction log will give a value close to Ro. However, in an oil zone with this same low Rmf/Rw ratio, Rt will be approximately 10 times Rxo and Ri, so that the induction tool will be considerably affected by the low resistivity invaded zone, and the reading will be much too low with fairly deep invasion. However, when Rmf/Rw is high, Rxo and Ri will be approximately the same as Rt for an oil zone, in which case invasion will have no effect.

For a water zone with this same high Rmf/Rw ratio, Rxo and Ri are much greater than Ro and the high resistivity invaded zone will have little effect on the reading which will be close to Ro even for fairly deep invasion.

Guard Log

The physical characteristics of the guard tool were discussed in Part 1, in which it was shown that the tool arrangement is such that a value close to Rt is obtained in a bed 1½ ft thick or greater regardless of the resistivity of the surrounding material. In broken porous sections which have shale breaks and sometimes hard streaks every few feet, it becomes very difficult to even approach Rt without good vertical discrimination from a log such as the guard.

Since the tool tends to be most affected by the highest resistivity within the path of the thin sheet of current which is forced to flow horizontally out from the well bore, a value close to Rt will be obtained even with relatively deep invasion whenever Rxo and Ri are close to the same value as Ro but less than Rt for an oil zone. Fig. 1 shows this concept in that whenever Rmf/Rw is less than 6, this relationship between Ri and Rt will exist. In a number of areas the formation water resistivity is quite high, such as in California, the brackish-water Frio and Wilcox of the Gulf Coast, and the brackish water in some of the Pennsylvanian section in the Texas Panhandle area. The normal mud programs in these areas give these low Rmf/Rw ratios. Of course, in areas such as West Texas and Kansas where salt muds are used, this low Rmf/Rw ratio is present.

FoRxo Log

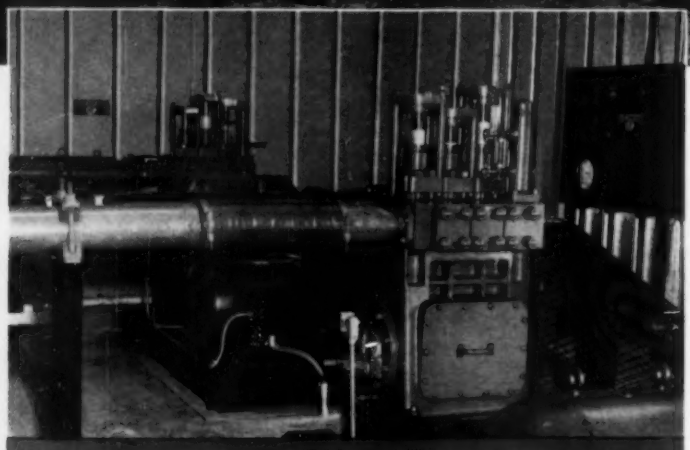
The FoRxo log is essentially a porosity log which is most useful in reservoirs with intergranular porosity. Frequently it functions well in fractured or vugular porosity reservoirs if the voids are quite small, so as to approach a homogeneous condition. However, it is important to note that the FoRxo log measurements of Rxo are essential to water saturation determinations, as well as being a means of measuring porosity.

Many factors relating to porosity determinations remain constant in any given well; therefore, to simplify as much as possible the use of the FoRxo as a porosity tool, appropriate porosity scales are placed on the bottom of each FoRxo log. (See examples in Fig. 4, 5, 6, 7, 8, 9, and 10.)

Since the only factors controlling the relative resistivity between Rxo and Rt are the Rmf/Rw ratios, residual oil saturation in the Rxo zone, and water saturation in the uninvaded zone, a comparison of shallow and deep inves-

TURN-KEY WATER FLOOD BY MID-CONTINENT

WITH SPECIAL PROTECTION AGAINST CORROSIVE FLUIDS



4500 barrels per day at 1200 lbs. psi flow through the unit's water flood system, pumped by two 4" stroke vertical triplex pumps with 60 hp electric motors.

WF1-0

In designing this water flood project near San Angelo, Texas to meet specifications of Hiawatha Oil & Gas Company as Operator of the Yan-Kee (Canyon) field unit, our engineers faced a corrosive water situation.* But long-term, trouble-free operation was designed into this job with proper corrosion resistant equipment. For example:

- **Clear water tank and filters are coal tar epoxy coated.**
- **Suction and discharge piping on injection pumps are plastic coated.**
- **Injection lines are cement coated.**
- **Pumps, meters, valves and control components are of special corrosion resistant materials.**

This close attention to detail and careful planning for local conditions is our basic rule on all secondary recovery problems. Let Mid-Continent's skilled technicians assist you. A wide choice of equipment for an economical water flood operation is always available.

*Cambrian water; specific gravity, 1.075 at 60°F; pH 6.8; temperature leaving supply well at 138°F.

MID-CONTINENT - SUPERMARKET FOR THE OIL INDUSTRY

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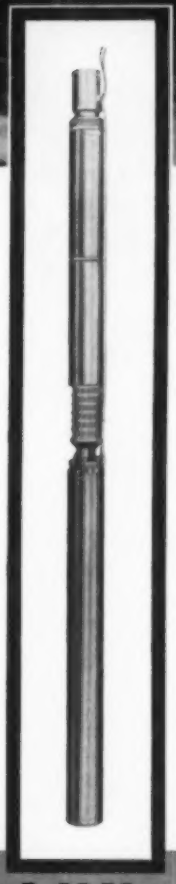
OVER 300 REDA PUMPS PROVIDE LOW-COST PRODUCTION FOR GREEN COUNTY, KENTUCKY

Photo Courtesy E. D. Blanchard, Aqua Well Drillers, Chattanooga, Tenn.



Small REDA Units Make Profitable Producers of High Water/Oil Ratio Wells

Using Reda Submergible Pumps, Green County producers have been able to profitably pump wells, proven unprofitable when other types of pumps were used.

The wells are shallow, producing from 350 to 600-foot depths. They have an average water/oil ratio of 10 to 1, with some as high as 100 to 1.

Small size Reda units were introduced into the field, and quickly replaced many other types of pumps of excessive cost and size.

TYPICAL REDA INSTALLATION:

PUMP: 34 stage, type A18E for 4-inch I. D. or larger casing
MOTOR: 3 H. P., 230 volt, single phase
FLUID LIFT: 600 B/D of fluid from 500-ft. depth setting
POWER COST: Approx. 67¢ per day (based on cost of 1¢ per KWH)

This is but one of many examples where experience-proven Reda units have proved to be the most efficient, most economical pump for the job!

FOR INFORMATION ON YOUR REDA APPLICATIONS, CONTACT

SIGN OF QUALITY SUBMERGIBLE REDA PUMPS

REDA PUMP COMPANY
BARTLESVILLE, OKLAHOMA
World's Largest Manufacturer of Submergible Pumps For Oil, Brine, Water, Gasoline, Jet Fuel, Chemicals And LPG, For Over 35 Years.

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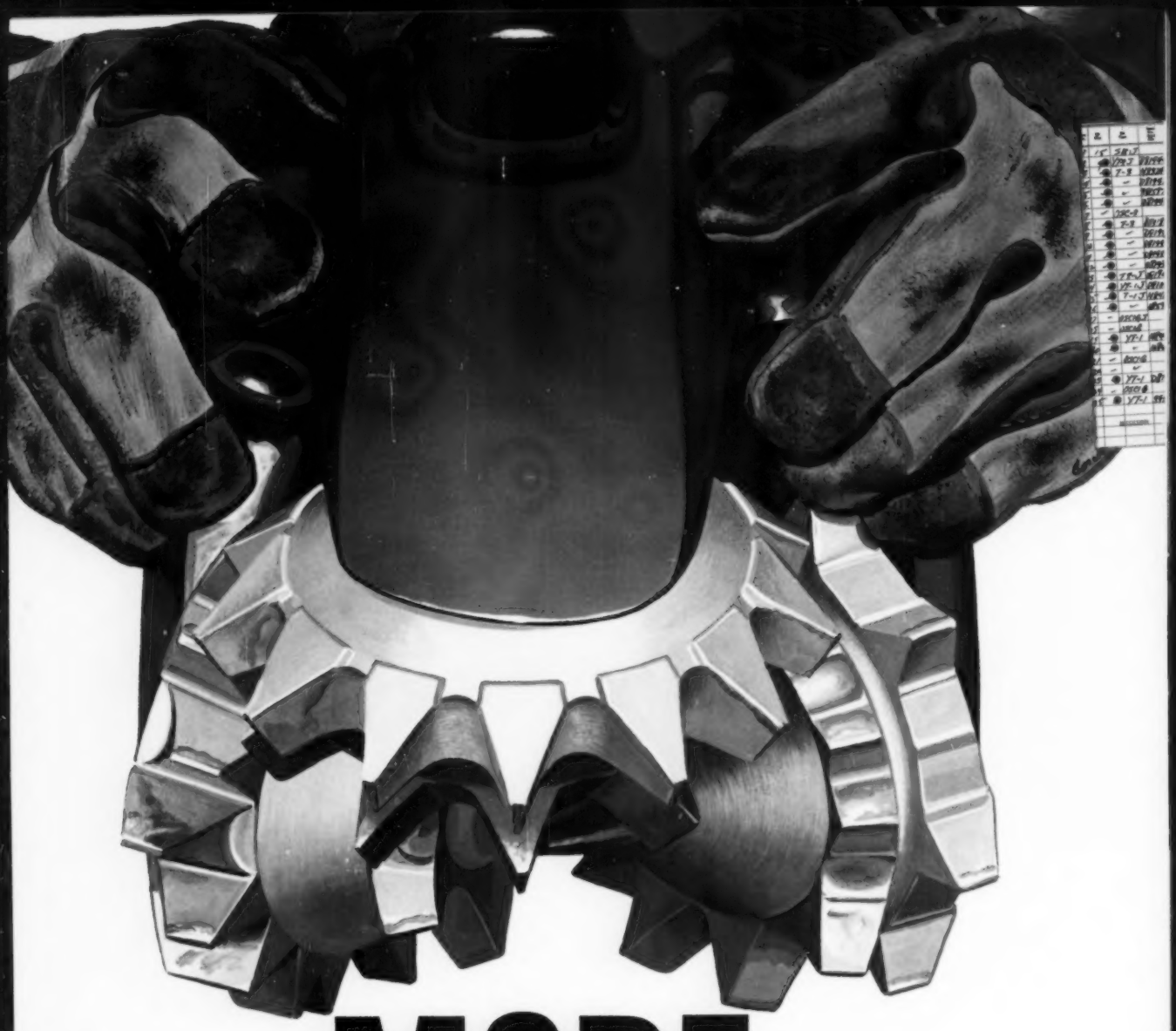
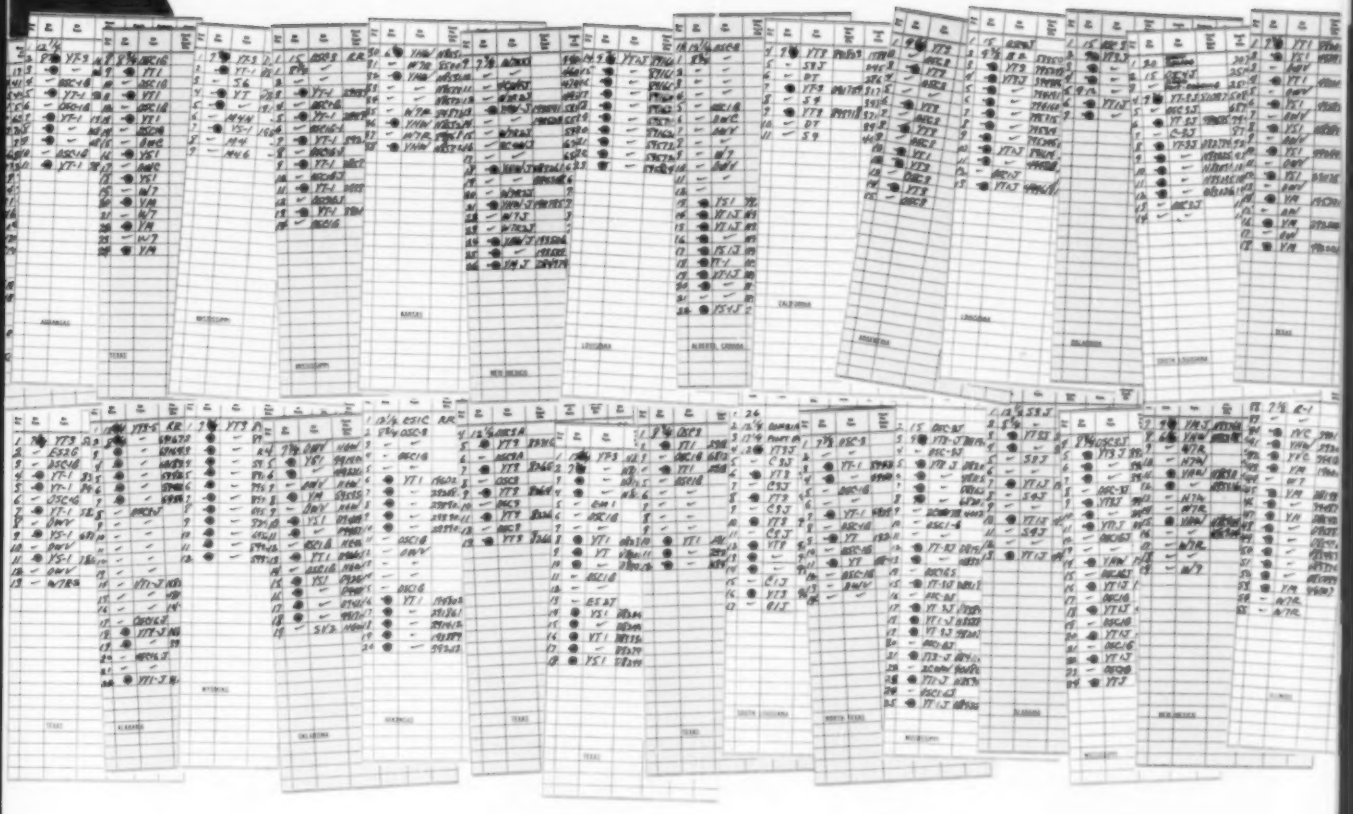


MORE

RIGS ARE RUNNING

MORE

REED BITS



and here's why . . . RECORD AFTER RECORD, FROM FIELD AFTER FIELD, PROVES IT!

The bit records shown above are representative of the competitive job Reed Y bits are doing all over the world.

Most people are using Reed Y bits today because they know that when they put a Reed Y bit in the hole it will do the job and do it right.

The performance of Reed Y bits in the past year has been so good that we have not, in some cases, been able to supply the quantities that have been demanded by our customers. To remedy this, we have expanded our production facilities and are now in a better position to supply your needs.

An expanded research and development program has enabled us to provide all the most popular sizes and types for immediate delivery and we are adding additional sizes and types on a regular, continuing basis. Each new size and/or type requires many hundreds of hours of research, engineering, and testing. When we release a bit to the field for sale, you can rest assured that it will dig with the best of them.

Run Reed bits on your next well—you'll be pleased with the results.

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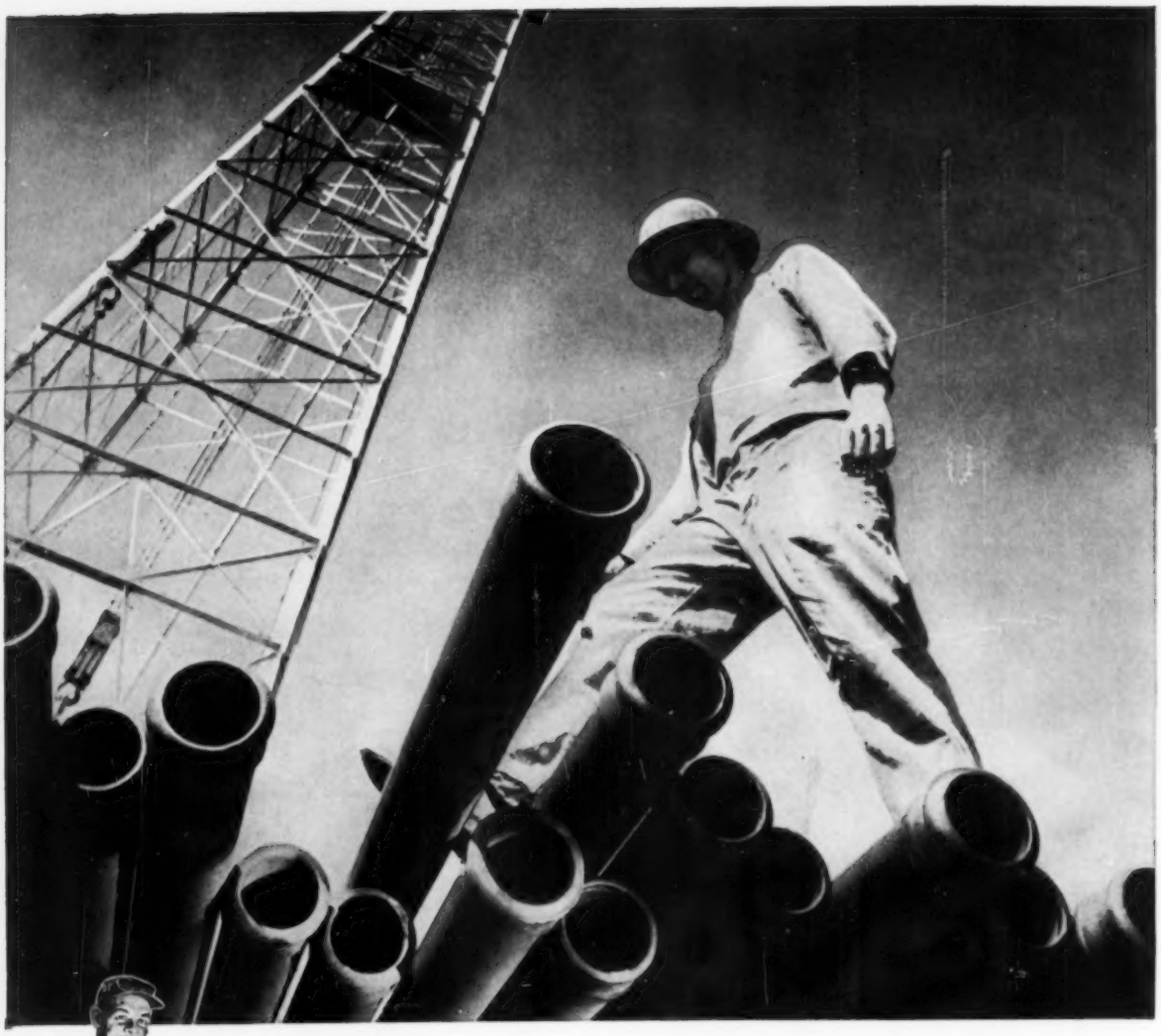
REED'S ROLLIN'



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Look at the company and what it represents. For the petroleum industry, the Image of CF&I stands for a high grade of seamless casing and tubing. The steel used is made by CF&I. Manufacturing facilities and equipment are among the most up-to-date in the industry. CF&I's production techniques feature unusually exact quality controls. For special technical problems, CF&I offers expert engineering services.

CF&I's mill is ideally situated in Pueblo, Colorado. Around it, a thousand miles in every direction, stretch the rich oil fields of North America. This location facilitates rapid delivery, either by rail or truck, even to the most remote sites. All CF&I Seamless Casing and Tubing is made to API specifications. It's available in sizes 2⅜" to 9⅝" O.D. Get full details from a CF&I Sales Representative or your local distributor.

7524

CF&I STEEL **SEAMLESS** *casing and tubing* API

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tigation devices will allow saturation calculations quickly and easily. The FoRxo log as previously discussed essentially measures Rxo to give this shallow investigation resistivity reading. Since the FoRxo is a focused measurement from a 1-in. button on a pad, the vertical discrimination is such that laminations only a few inches thick are clearly shown. Thus in combination with the guard quantitative analysis can be accomplished in very broken sections which ordinarily are very difficult to interpret.

In shaly sands this vertical discrimination from the FoRxo and guard will allow the determination of content from the calculations in the cleaner portion of thin sands. In the shalier portions the water saturation may be slightly high in oil zones and slightly low in water zones, but a comparison of the factors involved (Rxo, Ra, Rs, and Rmf/Rw) will usually give an indication of whether the free water saturation is lower or higher than the calculated values.

In combination with the induction log, the Rxo value can be picked for the particular section to which the induction tool is responding, thus eliminating as much as possible the effect of variable resistivity within the zone of influence on the tool. Also in the recommended conditions for the induction-FoRxo combination, Rxo and Rt for an oil zone are close to the same resistivity value; thus, the effect of shaliness on both Rxo and Rt will be in the same direction, so that the resistivity ratio of FoRxo/induction will not be greatly affected. The resulting calculations then will be indicative of true content. However, in water zones the effect of shaliness will usually result in water saturation values somewhat less than 100 percent — usually 70 to 80 percent — but by comparison of Rxo, Rs, and Ra, these can usually be rationalized. Since FoRxo is essentially reading Rxo, the scale can be relabeled directly on the log in the field as porosity using the applicable formation factor-porosity relationship and various values of residual oil saturation.

Saturation Calculations

Fig. 2 and 3 are the simplified saturation charts used for calculation, and they are attached to the logs in the field. The nomograph on the left is used to give the ratio of FoRxo to either the guard or induction reading, and this value at the proper Rmf/Rw value gives water saturation — the solid lines for 2d invasion and the dashed lines for 5d invasion. Measured Rw values from data in the area should be used where possible, but the SP scale

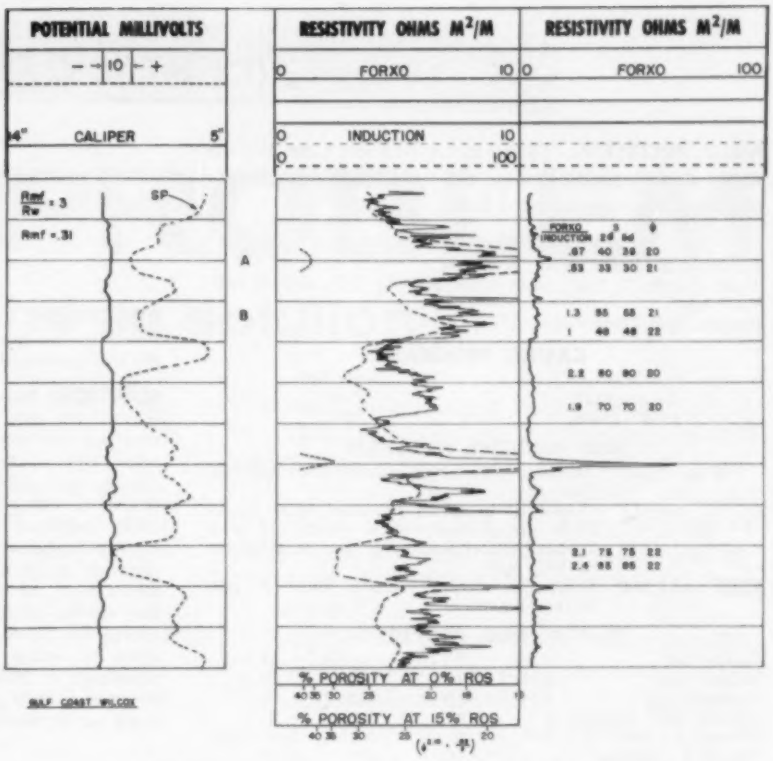


FIG. 4. Induction-FoRxo combination log in the Gulf Coast Wilcox.

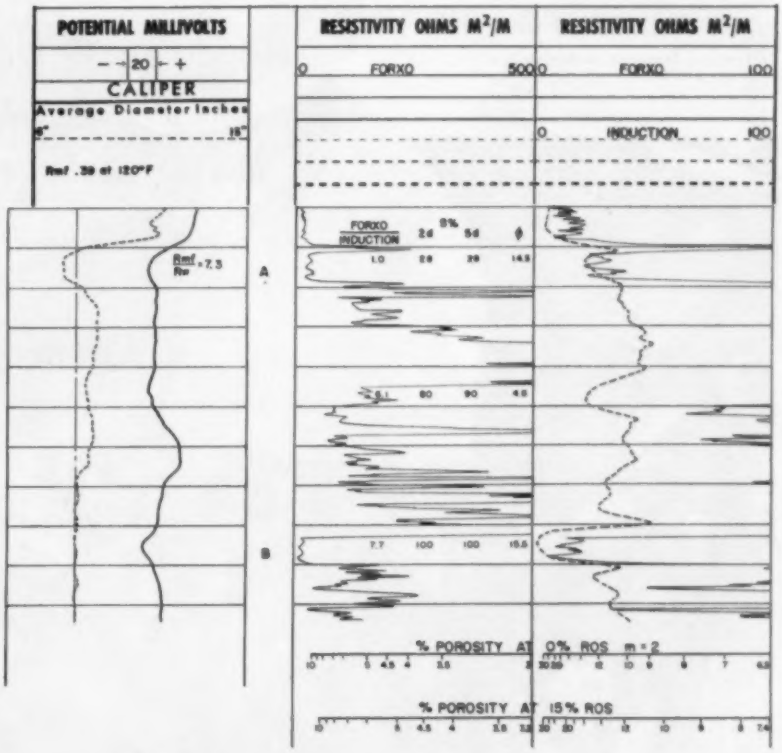


FIG. 5. Induction-FoRxo combination log in the Morrow Pennsylvanian of the Texas Panhandle.

You save drilling dollars with

THE

MUD PROBLEM: To protect formation from filtrate water damage and alleviate the two conditions of out-of-gauge bits and enlarged hole.

WELL DATA

Location: Sublette County, Wyoming
Total Depth: 11,564'. Hole from 506' to T.D. drilled with 7⅞" bits
Bottom Hole Temperature: 137°

CASING PROGRAM

Size Inches O.D.	*Depth Set Feet*
13⅜" casing	506

MUD ADDITIVE PROGRAM

0' to 9,323'	AQUAGEL*, TANNEX*, caustic soda and HV DRISCOSE†.
9,323'	Converted to invert emulsion made up of 60% diesel fuel, 40% water, 20 ppb INVERMUL*and BAROID*to give mud weight of 10.0 ppg.
9,323' to 11,564'	INVERMUL invert emulsion plus 13. ppb PETROTONE**.

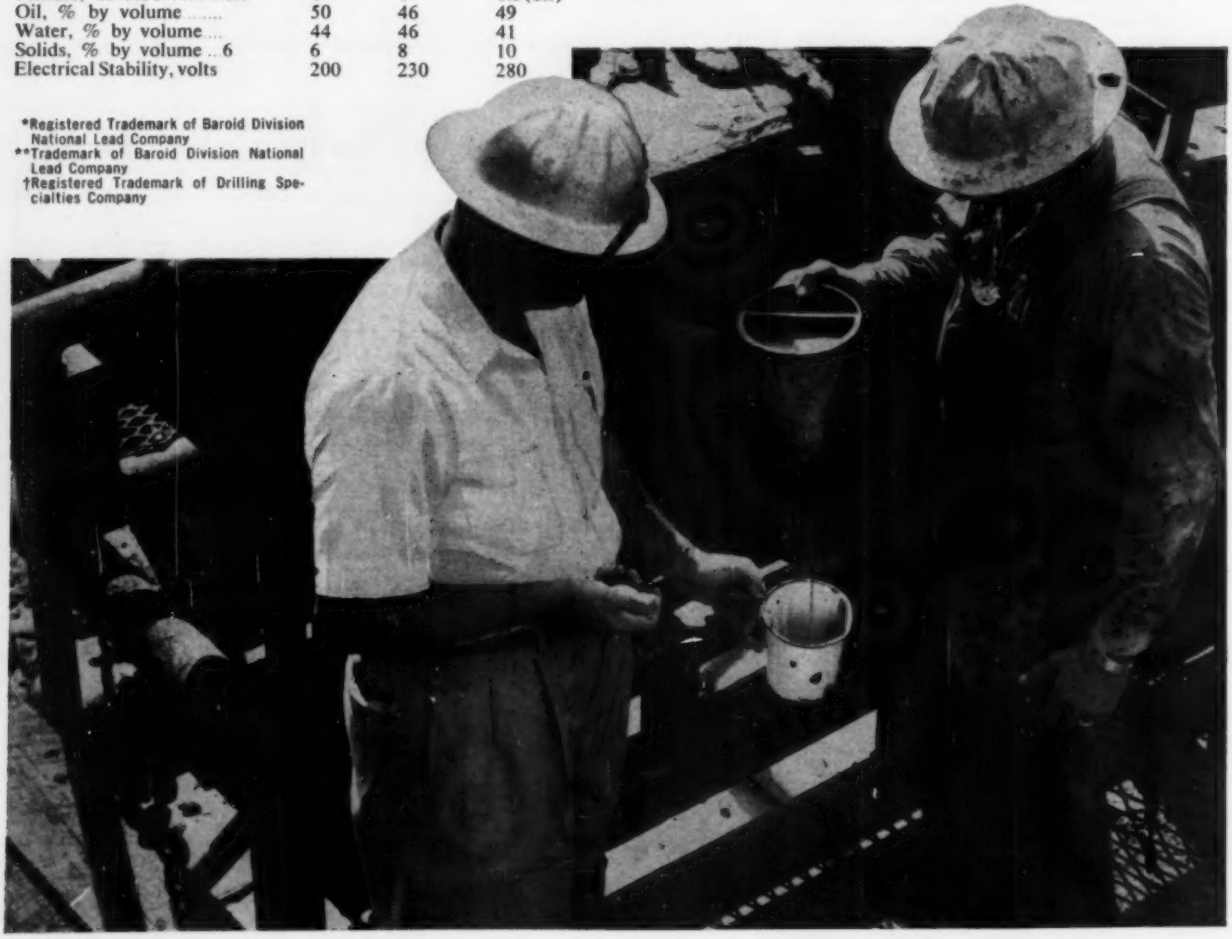
TYPICAL MUD PROPERTIES

Depth, feet	9,000	9,323	10,130	11,564
Weight, ppg	10.0	10.0	10.0	10.4
Viscosity, cps	45	100	123	87
Stormer Gel, 10 min	2	8	2	2
Filtrate, cc API	6.0	0	0	0.3(oil)
Oil, % by volume		50	46	49
Water, % by volume		44	46	41
Solids, % by volume	6	6	8	10
Electrical Stability, volts		200	230	280

*Registered Trademark of Baroid Division National Lead Company
**Trademark of Baroid Division National Lead Company
†Registered Trademark of Drilling Specialties Company

DISCUSSION: INVERMUL mud was used to protect the Mesa Verde section from damage by water filtrate and to alleviate the two conditions of out-of-gauge bits and enlarged hole.

SOLUTION: Invert emulsion mud, made with INVERMUL, was selected not only because API filtration could be reduced to zero but also because of its high tolerance for contaminating water base mud that would become mixed with it during displacement. Additional INVERMUL mud can be easily mixed at the rig with rig equipment and the mud properties can be easily controlled or modified.
During displacement an estimated 400 bbl of water base mud remained in the sections of washed out hole and later became mixed with the INVERMUL mud causing some API filtration and settling of solids. API filtration was reduced to zero by adding 5% diesel oil and 5 ppb INVERMUL. Settling was eliminated by adding 1.3 ppb PETROTONE, a product specifically developed by Baroid for imparting suspending properties to invert emulsions and oil base muds. No out-of-gauge bits or worn out bit bearings were reported.



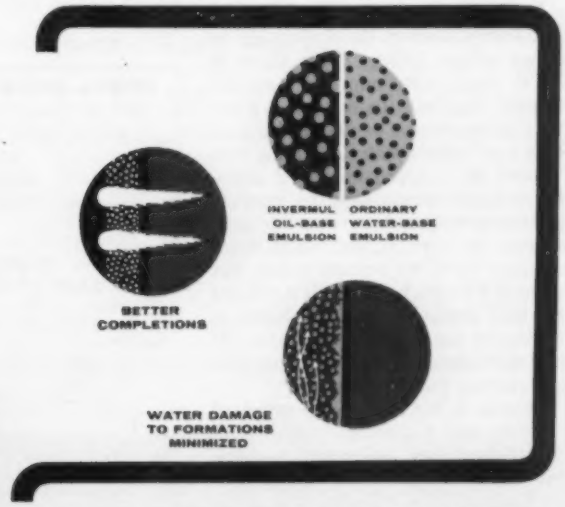
a Baroid Mud Program

MUD PROBLEM

...and its solution

This case history demonstrates again how Baroid provides the right combination of mud products to solve drilling difficulties. In this instance the problems associated with drilling in a long section of open hole (11,058′) were: prevention of water filtrate to the formation, reduction of hole enlargement, and elimination of reaming due to out-of-gauge bits. These problems were solved by selecting INVERMUL oil base emulsion mud. The high tolerance of INVERMUL mud to contaminating water base mud proved to be a definite advantage. Approximately 400 bbl of water base mud from enlarged sections of the hole, became mixed with the INVERMUL mud. The resultant settling of solids and filtration increase were quickly corrected by adding INVERMUL, oil and PETROTONE.

Successes such as this are made possible by Baroid's integrated program that quickly brings specialized products and engineering skill to solve your mud problems.



BAROID

BAROID DIVISION NATIONAL LEAD COMPANY

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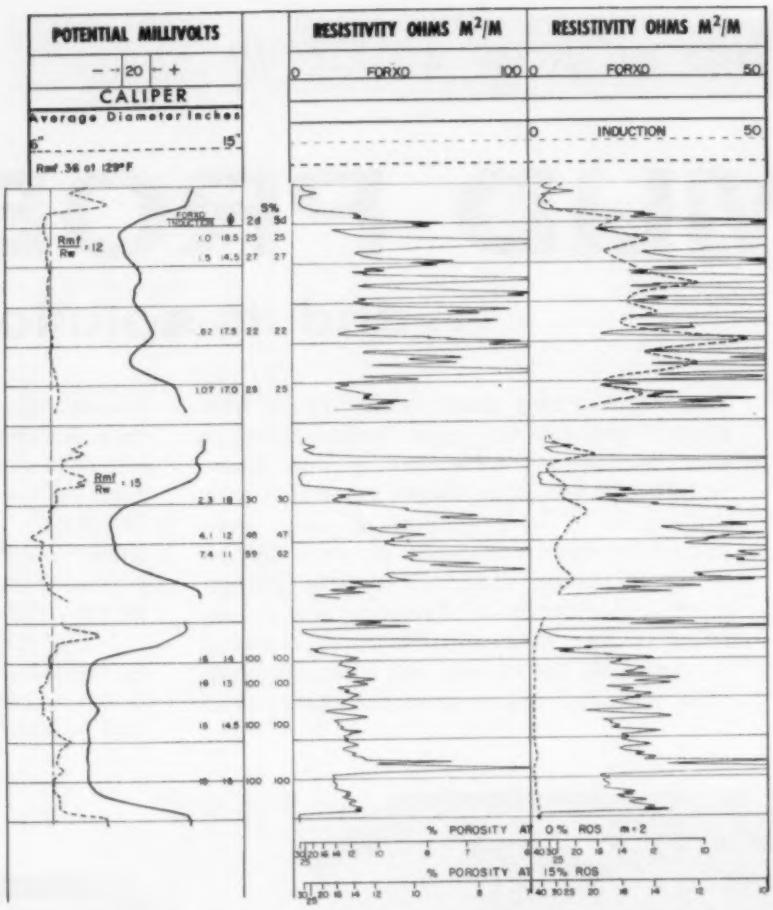

FIG. 6. Induction-FoRxo combination log in the Cherokee Sand of the Texas Panhandle.

is provided at the top for use when necessary.

It will sometimes be advantageous to determine what Rmf/Rw ratio is necessary to make a known water zone, if available, calculate 100 percent water as a double check on the Rmf/Rw ratio in the zone of interest. No corrections on the SP scale are included for the nonequality of the resistivity and activity ratios in very high or low salinity formation water, and it will sometimes be necessary to make such a correction using published data[1] or the Welex "Production Guide" slide rule.

These saturation charts are of additional value in that most of the variables are included on one page so that the effect of variations will easily indicate the direction of the true water saturation value.

INDUCTION FoRxo EXAMPLES

Fig. 4 is an example of the induction-FoRxo combination in the Gulf Coast Wilcox and in the lower range of Rmf/Rw ratio application — Rmf/Rw = 3. The induction resistivity and SP have been traced on the FoRxo log as dashed curves. Except in the sands A and B, the FoRxo/induction ratio approaches the Rmf/Rw ratio of 3, especially in the cleaner sands. In this case Rs is 4 to 5 ohms with Rxo values 6 to 7. Since Ro is approximately 2 ohms, the shaliness would tend to increase Ro considerably and decrease Rxo only slightly. As a result, the water sands calculate 70 to 85 percent water, but realizing the effect of shale, it is evident that they contain only water. Some of the shalier sands as shown by the SP have induction and FoRxo resistivities approaching that of the shale.

In sand A the induction reading of 16 ohms and FoRxo of 8 ohms indicate hydrocarbon production, and the well was completed there as oil. Zone B calculates 48 to 55 percent water as shown on the figure, but as shown by both the SP and FoRxo, a shale streak is present in the middle of the sand of about 10 gross ft. Such a condition approaches two 4 to 5-ft beds which would require a bed thickness correc-

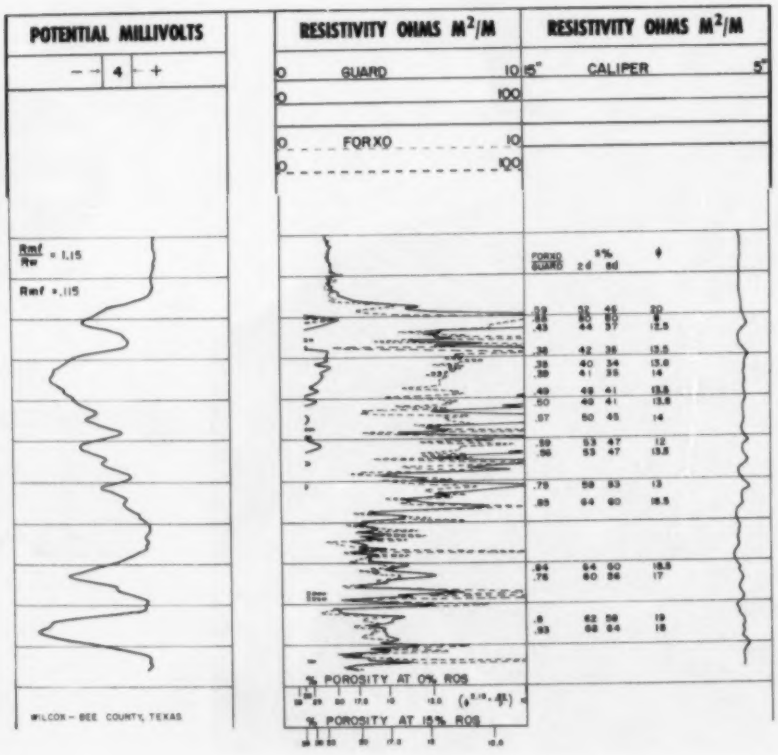

FIG. 7. Guard-FoRxo combination log in the Gulf Coast Wilcox.

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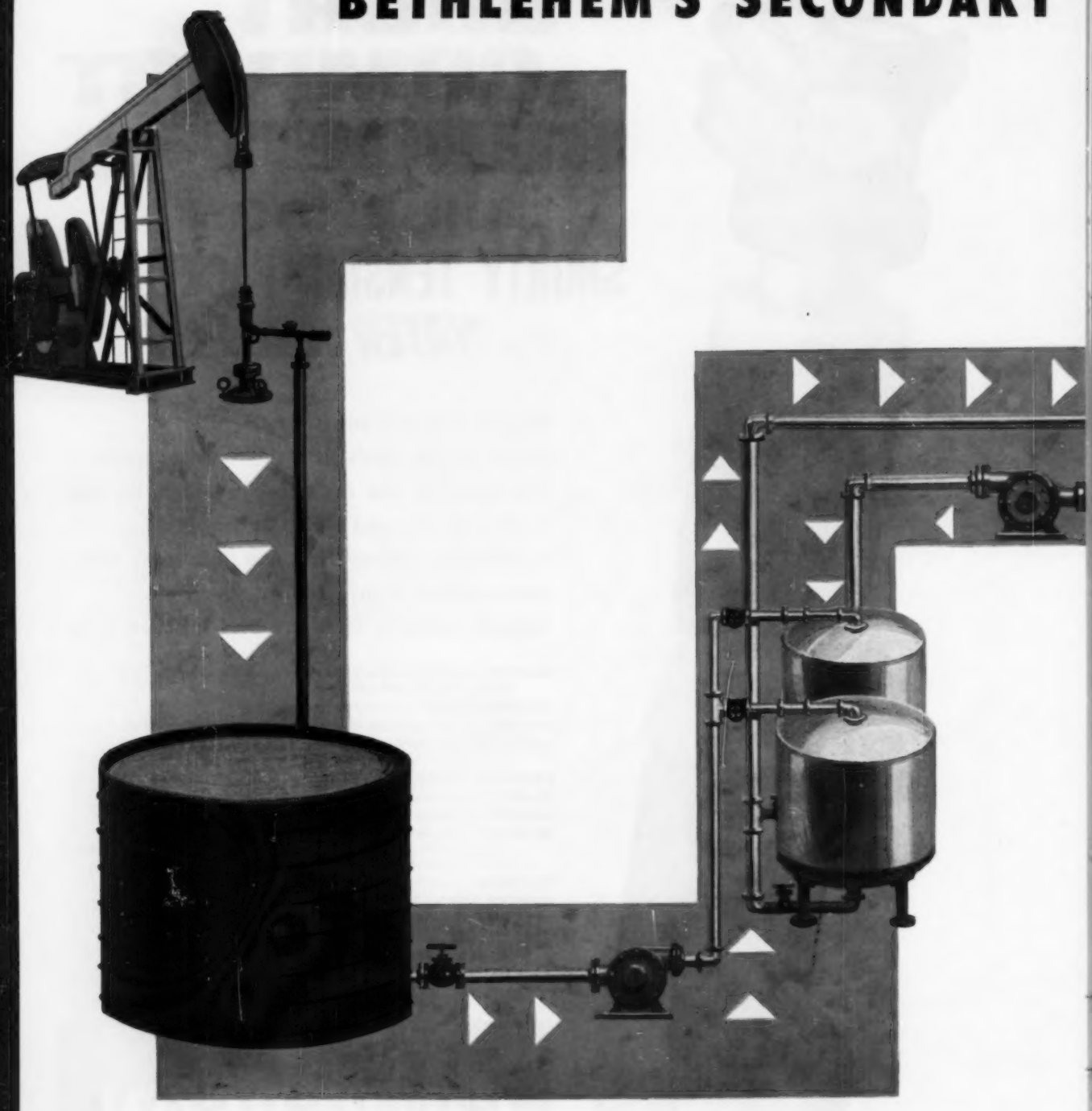

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tion, and since Rs is less than the apparent induction resistivity, the apparent induction value would have to be corrected upward. This would lower the calculated water saturation as indicated by Fig. 2. Zone B does contain oil. The tabulated porosities are taken from the porosity scale at the bottom of the log and are in agreement with field core analysis.

Fig. 5 is an example of induction-FoRxo in the Morrow Pennsylvanian of the Panhandle. With the Rmf/Rw ratio of 7.3, Rxo and Rt would be approximately equal in an oil zone as shown by Fig. 1. In Zone A the induction resistivity and lower FoRxo values coincide showing that Rxo = Rt = 22 ohms which gives 28 percent water saturation from Fig. 2. Although FoRxo shows quite variable porosity over this 7-ft interval, the induction is clearly responding to the streaks of higher porosity (lower resistivity) every 2 ft with little effect from the tighter streaks. This combination allows the Rxo value to be picked for the porous streaks to which the induction is responding. The short normal over this zone read 60 ohms which would indicate high water saturation, but the influence of the high resistivity above and below the porous zone is such that the short normal will read too high. Zone A was completed as an oil well.

Zone B is shown to be quite variable porosity by FoRxo with a considerably lower induction resistivity value such that the ratio is the same as the Rmf/Rw ratio, thus indicating the 100 percent water content.

Fig. 6 is another induction-FoRxo log from the Panhandle. The upper zone is the Cherokee sand, and again the induction resistivity is coinciding with the lowest FoRxo readings in the higher porosity zones, which with the Rmf/Rw ratio of 12 indicates a low water saturation. The zone produces gas.

In the second zone, which is Morrow Pennsylvanian, the FoRxo is reading 2.3 times the induction in the 3-ft porous zone at the top. Since Rs, the resistivity of the surrounding beds, is considerably greater than the resistivity of the 3-ft porous zone, the induction resistivity will be close to Rt in so thin a zone. With the Rmf/Rw ratio of 15 this zone calculates to be 30 percent water. The increased water saturation values below this porous streak indicate a possible transition zone which was borne out by completion — the top 10 ft produced oil on completion but rapidly increased in water production.

The lower zone is shown to be relatively homogeneous and porous with FoRxo/induction ratios 14 to 16 which they should be for the Rmf/Rw ratio of 15.

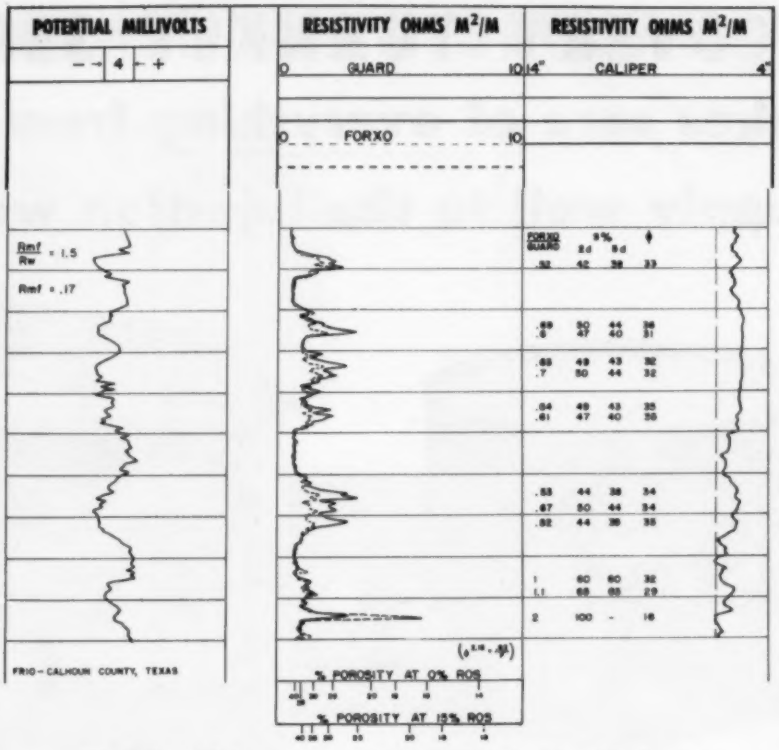

FIG. 8. Guard-FoRxo combination log in the Gulf Coast brackish-water Frio.

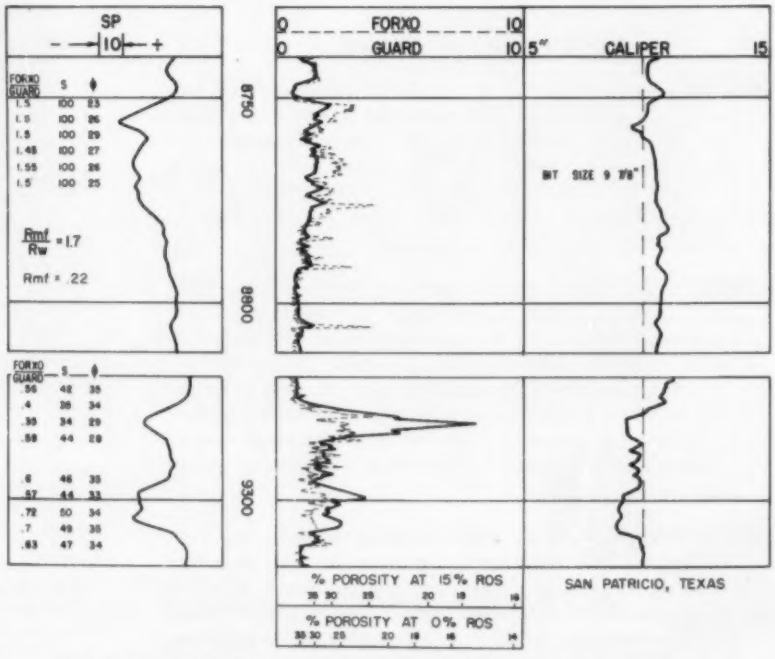

FIG. 9. Guard-FoRxo combination log in the brackish-water Frio of the Gulf Coast.

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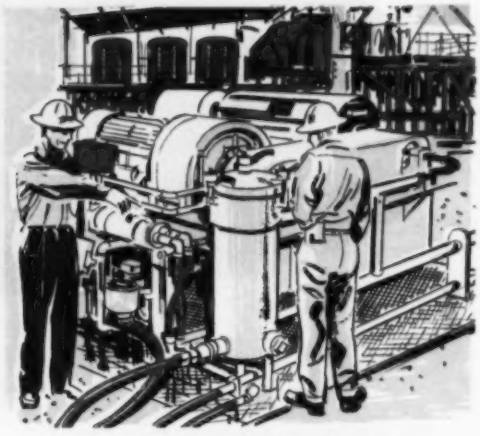
When 12,693 feet was reached, the mud viscosity was extremely hard to control, due mainly to high solids contamination. The mud bill on this well was $127,232.00 to a depth of 12,829 feet.



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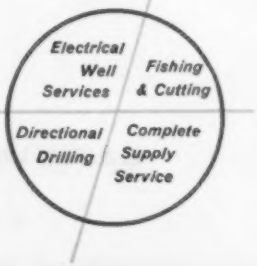

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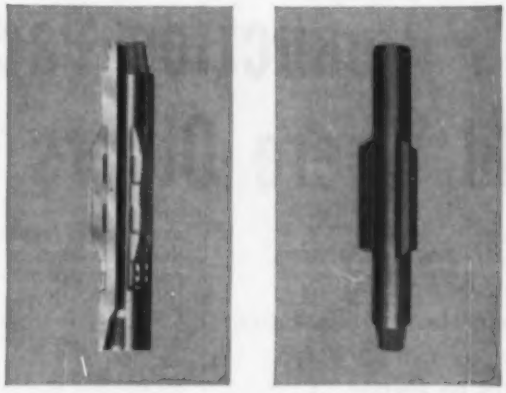

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OTIS PRODUCTION NEWS

Volume I, Number 1 **Otis Engineering Corporation • Dallas** *Production Equipment and Services*

Special Report from West Texas

Otis Production Packers Hold Where Others Fail

High Pressure, Strain, Tubing Vibration in Gas-Injection Wells Cause Bodies of Competitive Packers to Part

MIDLAND — Type WA Otis Production Packers have proved to be the solution to a serious problem encountered by a West Texas operator on a secondary recovery project. The problem was to find a packer that would stand the stress and vibration of the tubing in a number of high-pressure gas-injection wells.

The wells involved were being used to inject gas into the Devonian at approximately 12,500 feet. Injection rate was 2½ M.C.F.D. at 7,500 P.S.I. Due to vibration created by this high rate of injection, the tubing was set in tension with a minimum of 25,000 pounds' strain. These conditions apparently proved too strenuous for the packers used in the initial completion for they disintegrated shortly after the wells were put into operation.

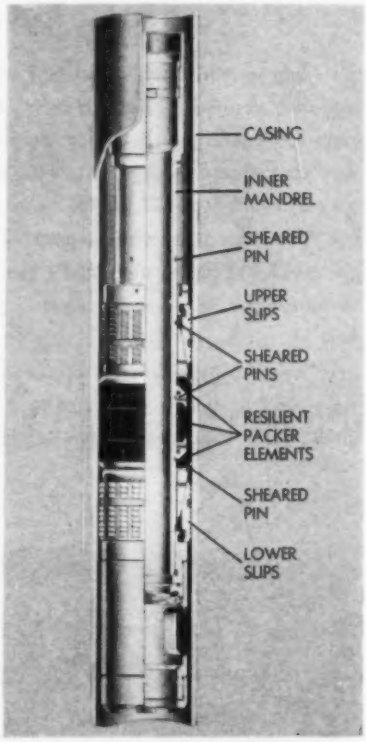
In analyzing this producer's problem, Otis packer specialists from the Odessa office felt confident the Type WA Otis Production Packer would stay in the hole in spite of the adverse working conditions because of the packer's "floating mandrel" design.

See diagram this page

This feature, unique among permanent-type retainer packers, is designed to prevent problems such as this which result when a packer's inner mandrel is permanently attached to the slips or packer body.

Unlike the packers originally used in these wells, the inner mandrel of the Type WA Otis Packer is not pinned to either the upper or lower slips, or the rubber element assembly, once the packer has been set. The mandrel is free to travel up or down within the outer packer body approximately 8 inches before being confined by a shoulder at either end, and is sealed off and held in position by O-rings and pressure from the compressed rubber packer elements. In this way, vibration or movement of the tubing string when transmitted to the packer mandrel is partially absorbed by the rubber packer elements first, and not directly transmitted to the slips or the outer packer body.

As a result, Type WA Otis Production Packers have replaced the packers originally used in these injection wells and the operator reports all have proved satisfactory. Several additional wells are to be drilled for this project and Type WA Packers have been specified for each.



When setting the Type WA Otis Production Packer, all pins holding the slips and resilient packer elements in the running position are sheared and the mandrel is free to float.

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Drilling and Producing Division Heralds Otis' Entry Into Packer Field As 'Good News'

DALLAS — The news that Otis has acquired a new line of field-proven production packers and bridge plugs, and is now offering a "packaged" well completion service, has been well received by the drilling and producing division of the petroleum industry.

For the last 25 years, producing companies and packer manufacturers both have looked to Otis for guidance when engineering difficult well completions. Now, with its own line of packers, Otis will provide the industry a "packaged" well completion service to include both engineering and all sub-surface equipment.

The present line of Otis packers includes a series of Type WA Wire Line Set Drillable Retainer Packers which can be set on any wire line pressure setting tool; three tubing or drill pipe set packers which carry the designations Type TA, TB, and TE; a Type RA Retrievable Packer designed to be set in tension or com-

(See "Good News," Page 2, Col. 2)

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Better Production Tools Through Research

Otis-Engineered Dual-Completion Saves Tubing Job 30 Days Following Initial Completion

THOMPSON CREEK FIELD, MISS. — A well, dually-completed in this western Mississippi field in November, 1959, produced approximately 200 B.O.P.D. from each zone immediately following completion, however both zones had to be put on pump in less than thirty days due to a decrease in bottom-hole pressure. The well completion, engineered by Otis specialists in that area, was designed to permit the operator to flow this well as long as economically feasible, then put both zones on pump without pulling tubing.

The well was completed with two packers, a dual and a single, a Type S Otis Landing Nipple and a Type A Otis Sliding Side-Door between the two packers for plugging and circulating purposes, and two Type S Otis Landing Nipples above the top packer in each string.

See schematic diagram — right

The conversion of this well to artificial lift was accomplished by landing Type S Otis Pump Locators and Hold-Downs in the top S nipple of each string and installing the pumps. As the zones deplete, the pump locators and hold-downs may be reset in the lower nipple of each string simply by pulling the pumps, retrieving the locators and hold-downs, changing the selective keys on the locators, and re-running the tools to the lower nipple. By using Type S Otis Landing Nipples instead of regular A.P.I. pump seating nipples, the tubing remains full-opening to permit running through-tubing perforating guns, bottom-hole pressure bombs, and other wire line service tools. Also, plug chokes and other Otis sub-surface flow control equipment may be set in any of the S nipples should it become necessary.

Good News

(Continued from Page 1)

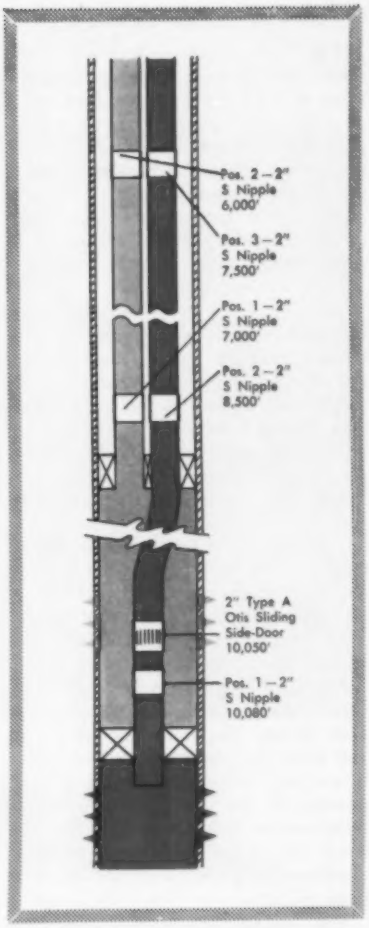
pression without modification; the Type HS Retrievable Isolation Packer which is set hydraulically, and two retrievable collet-type packers — one for slim-hole work and the other a regular casing collet-type packer.

A stepped-up research and development program is expected to produce several new types of packers in the immediate future to further round out the line of packers Otis already offers.

As part of the company's expansion program into the packer and bridge plug field, highly skilled packer specialists have been added to the staff of each Otis division. These men, working with other Otis well completion experts, form a team that operators can look to for a "packaged" well completion . . . as a single supply source for *all* necessary sub-surface completion equipment — from the wellhead to the plug on bottom.

Tool and Service Information

For additional information on any of the equipment reported in this issue of the Otis Production News, contact your nearest Otis office or write Otis Engineering Corporation, Dept. 1-P, Box 35206, Dallas 35, Texas. You'll find your Otis specialist ready to help you — anxious to serve you.


Pos. 2 – 2" S Nipple 6,000'
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Pos. 1 – 2" S Nipple 7,000'
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2" Type A Otis Sliding Side-Door 10,050'
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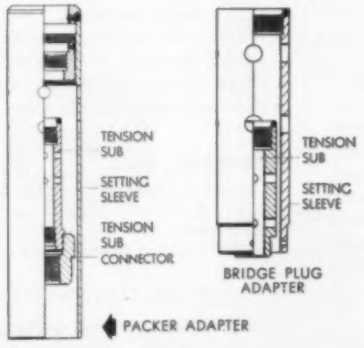

New Otis Packer and Bridge Plug Pressure Setting Tool Adapter Kits

Special pressure setting tool adapter kits have been developed to permit Type WA Otis Production Packers and Otis Wire Line Bridge Plugs to be set on the No. 20 pressure setting tool. Both of the adapter kits are extremely simple in design and can be easily made up with the setting tool.

The packer adapter kit consists of a tension sub, setting sleeve, and tension sub connector which is made up on top of the WA packer on the rig floor. The adapter for the bridge plug consists of only two sub-assemblies, a tension sub and a setting sleeve.

Both kits have been extensively tested in the laboratory and in the field, and neither has failed to operate as designed.

GUARD-FoRxo EXAMPLES

Fig. 7 is a guard-FoRxo log in the Gulf Coast Wilcox. With the Rmf/Rw ratio of 1.15 the FoRxo/guard ratios of 0.35 to 0.6 over the upper section give low water saturation calculations on Fig. 3. In the lower sand stringers the higher FoRxo/guard ratios give higher water saturation values which would be interpreted as transition to water. The upper section was completed for gas production.

As shown by all curves, the sands are very broken with numerous thin shale streaks and hard streaks. The detail afforded by this combination allows saturation determinations under these very adverse conditions. It is interesting to note that each small indentation on the amplified scale SP is shown to be a shale streak by both FoRxo and guard and the hard streaks show no curvature on the SP. Over the upper section all of the sections showing curvature on the SP, thus indicating the presence of porosity, have guard readings higher than FoRxo. As a result net pay can easily be determined.

Fig. 8 is the guard-FoRxo combination in the brackish-water Frio in the Gulf Coast. The sands are very thin and shaly but the vertical discrimination allows an analysis in the cleaner portions of the sands which indicates hydrocarbon production in all of the sands except the lower one, which is confirmed by production tests and field data.

Fig. 9 is another guard-FoRxo combination in the brackish-water Frio of the Gulf Coast. With an Rmf/Rw of 1.7 the section 8750-90 ft is calculated to be 100 percent water while the two lower sands calculate 34 to 50 percent water. The bottom sand is shaly and since Rt is greater than Rxo with Rs still lower, the guard resistivity would be more affected by the shale content. As a result, shale corrections would result in a lower FoRxo/guard ratio and lower calculated water saturations. The two lower zones produced gas.

Fig. 10 is this combination in the San Andres in West Texas with an Rmf/Rw ratio of 0.8. The beds are quite broken, but the productive interval is readily apparent with a transition zone shown toward the bottom. As usual in this formation, the porosity is very variable, but the determination of net pay can be easily accomplished.

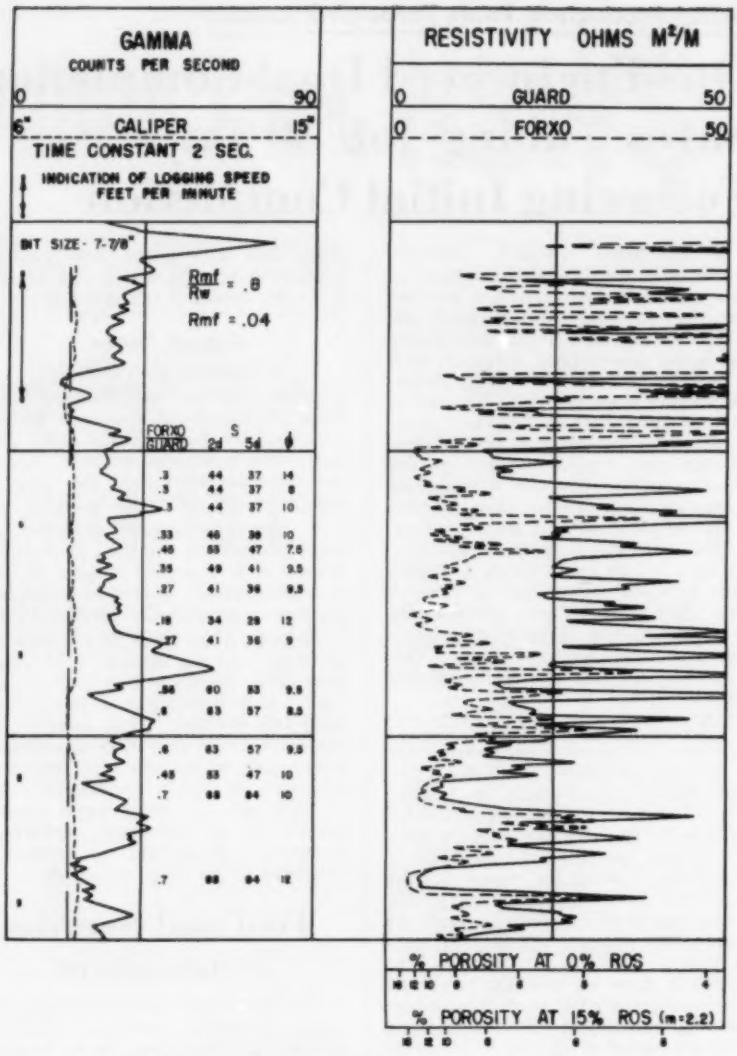

FIG. 10. Guard-FoRxo combination log in the San Andres in West Texas.

Summary

In summary, these examples show the utility of the two combinations as applied to the problem areas. Good vertical discrimination is necessary under these conditions, and in some cases it will be necessary to analyze the thicker porous zones and realize that in the thin streaks the answer may not be too reliable. Porosities and net pay indicated by the FoRxo in combination with the guard or induction are reliable. Of course, assumptions of residual oil saturation are necessary but relatively large errors in this assumption produce relatively small error in porosity determination, and any similarly produced errors in water saturation calculations are negligible. In addition, this estimate can be refined as core data becomes available in a field development program.

It is important to note that the saturation indications which are the primary objective in the early development stage can be obtained quickly with no error because of assumptions of cementation exponent.

With such excellent results of the simplified methods in these more difficult areas, similarly good results will be produced in nearly all areas.

Reference

1. Southwick, Stanley H., Kerver, J. K. and Winsauer, Weldon O., "Electric-Log Interpretation is Made Easier by the Use of Nomographs," Oil & Gas Journal, November, 1958.

TO BE CONTINUED

Part 3 of the series will discuss applications of the radioactive logging device in radiation induction logging and radiation guard logging.

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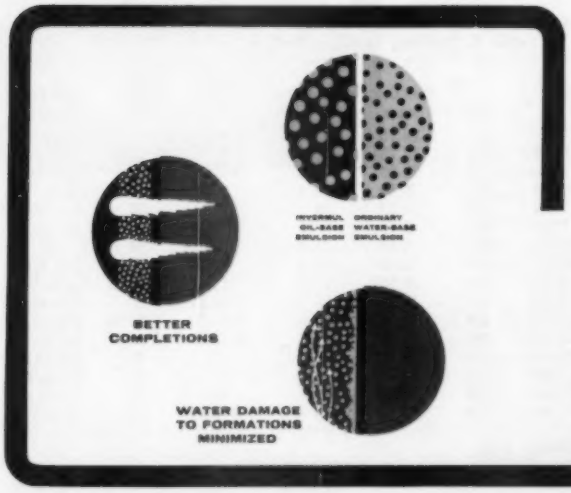

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Application and evaluation of . . .

Air-Hammer Drilling in the Permian Basin

Latest tests of the relatively new air-hammer drill in the Permian Basin credit the tool with doubling average penetration rate, reducing deviation considerably, and extending bit life by twice that obtained with air-rotary

H. F. Downs, *Technical Drilling Service, Inc., Midland, Texas*

AIR-HAMMER DRILLING, introduced just a few years ago with the promise to increase drilling penetration rates and bit life, has undergone continuous field testing since that time to determine its relative success. The most significant field testing has taken place in the Permian Basin of West Texas. This report is intended to continue reporting of air-hammer drilling evaluation first presented by Howard, Vincent and Wilder[1] and Liljestrand.[2]

The five wells described herein are located in the Permian Basin of West Texas and include drilling in the Sheffield Channel and the Delaware Basin. Two wells, reported by the previously mentioned authors, are not included in this report.

Where direct comparisons are available, it is concluded that penetration rates may be doubled by use of the air hammer, with occasional drilling rates three to four times greater than air rotary. Reduction in deviation by air-hammer drilling is credited with excellent results within the Permian Basin, while maintaining high penetration rates. Air-hammer bit footage was extended in specific instances and overall averages indicate much greater footage per bit may be expected when compared to rotary air drilling.

Since the basic design of the air hammer permits optimum performance between 200 and 300 psi air pressure, no changes in the normal air-compressor services for air drilling have been required, other than 10 to 20 percent more volume to maintain a clean hole while drilling at higher penetration rates.

Presented at the Spring Meeting of the Southwestern District, Division of Production, American Petroleum Institute, Dallas, Texas, March 2-4, 1960, under the title "Application and Evaluation of Air-Hammer Drilling in the Permian Basin."

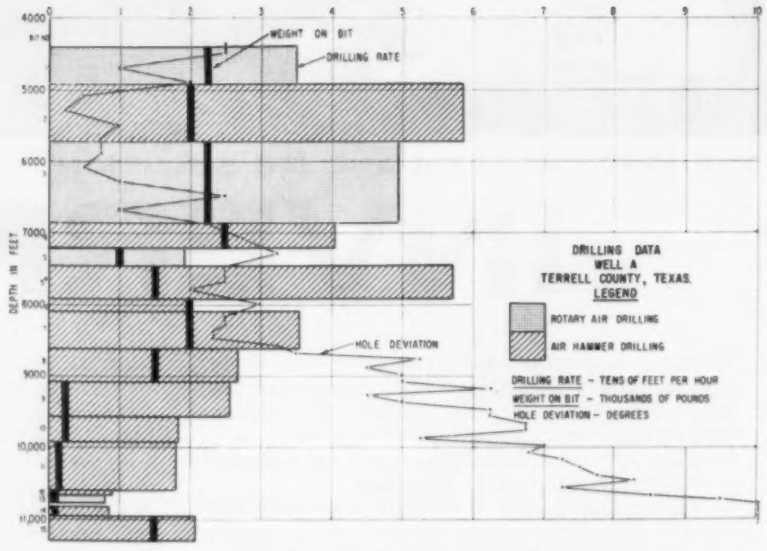
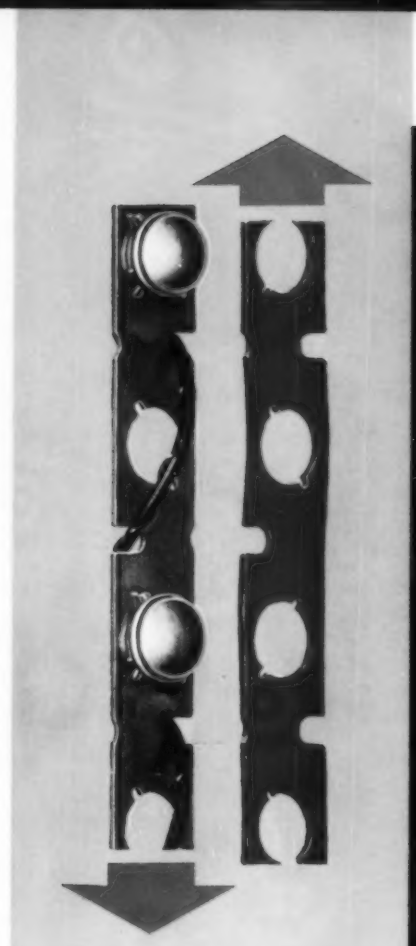


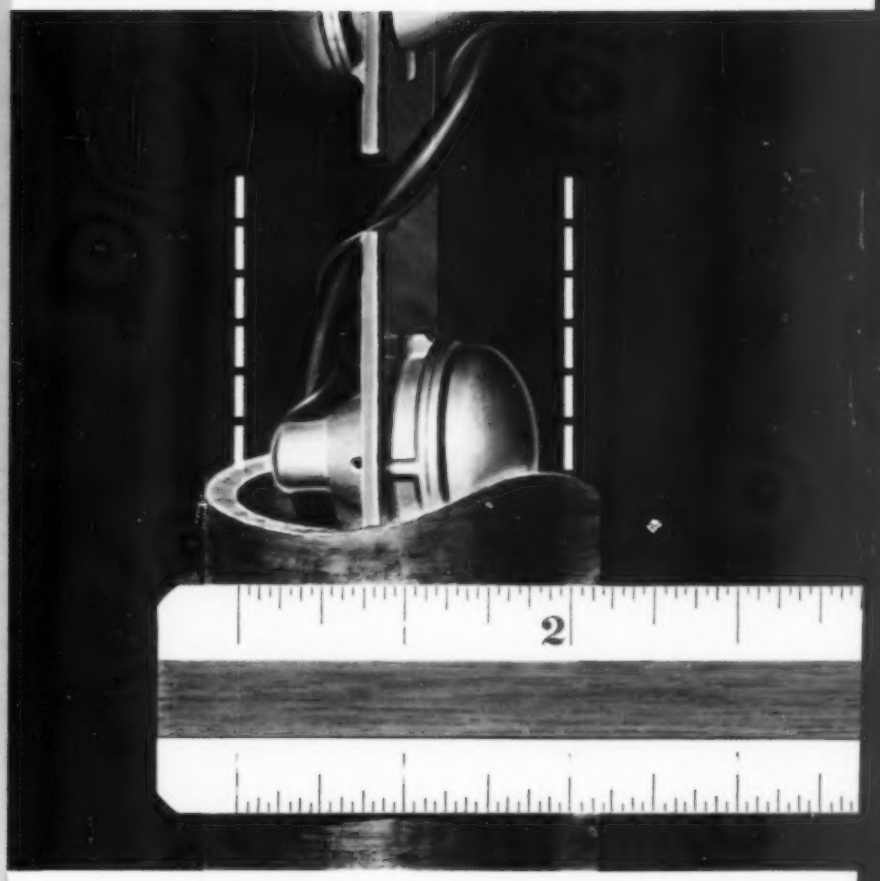
FIG. 1. Drilling data for a well drilled in Terrell County, Texas, compares penetration rate and hole deviation as achieved with rotary-air drilling and air-hammer drilling.

Table 1. Drilling Data — Well A.

No.	Bit Type	Depth from-to	Feet	Rotating hours	Penetration rate (ft/hr)	Weight on bit (1000 lb)	Rotary speed (rpm)	Deviation (degrees)
1	Tooth	4,414— 4,925	511	16.75	30.5	20 to 25	60	1½ to 3
2*	Tooth	4,925— 5,728	803	13.75	58.4	20	60	¼ to 1
3	Tooth	5,728— 6,880	1152	23.25	49.5	20 to 25	60	¾ to 1½
4*	Tooth	6,880— 7,223	343	8.50	40.4	25	60	1½ to 3¼
5	Insert	7,223— 7,462	239	12.50	19.1	10	60	3 to 3½
5*	Insert	7,462— 7,930	468	9.25	50.7	10 to 20	60	2¼ to 3
6*	Tooth	7,946— 8,111	165	5.00	33.0	20	60	2¼
7*	Insert	8,111— 8,651	540	15.25	35.4	20	60	3 to 3½
8*	Insert	8,651— 9,102	451	16.75	26.9	15	32 to 45	3¼ to 5¼
9*	Insert	9,102— 9,602	500	19.50	25.6	0 to 5	30	5 to 4½
10*	Insert	9,602— 9,958	356	19.25	18.5	0 to 5	30 to 60	6 to 6¼
11*	RR (5)	9,958—10,618	660	36.50	18.1	0 to 3	40 to 80	6¼ to 8
12*	Tooth	10,618—10,691	73	8.00	9.1	1	65	7¾ to 8
13	Tooth	10,691—10,809	118	14.75	8.0	1	60	8½ to 10
14*	Insert	10,845—10,973	128	15.00	8.5	1	60	8½ to 10
15*	Insert	10,991—11,330	339	16.25	20.8	10 to 20	35	10 to 11

*Denotes air hammer use
Hours rotated and penetration rate includes connection time





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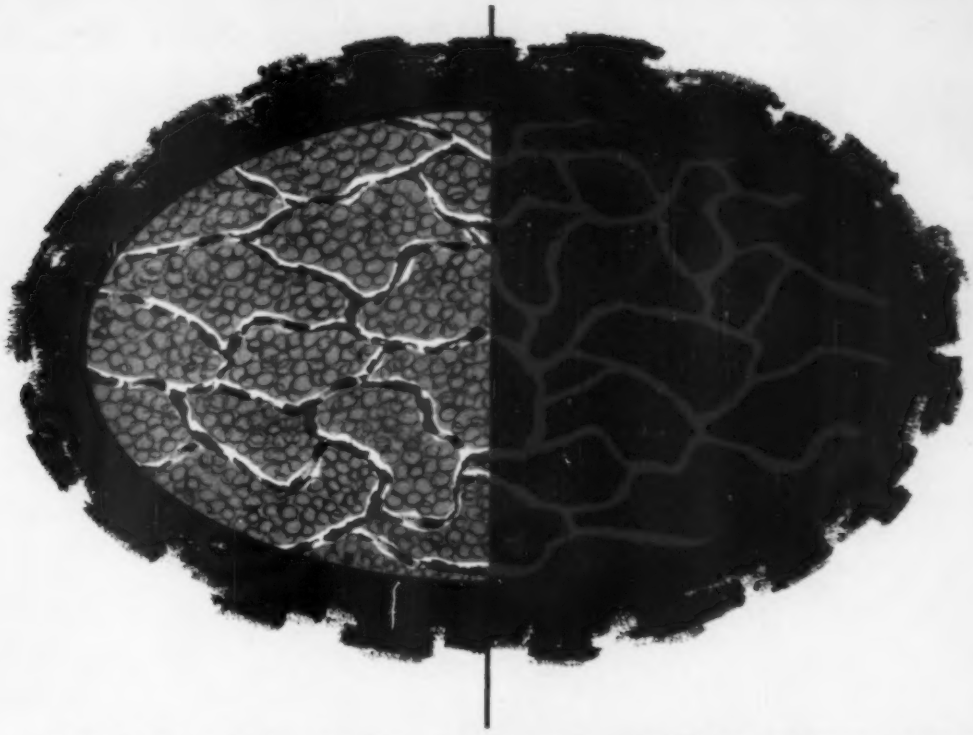

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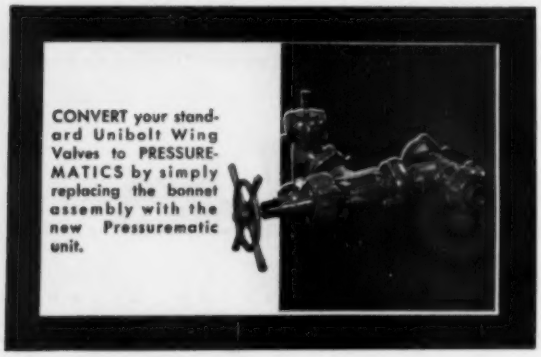
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Field tests on two new accessory tools were used in certain wells included in this report. A new top-hole float gave excellent performance and a newly designed bottom-hole float was also used with favorable results.

These tests further indicate the need for additional research in deviation control. Bits designed for use with the air hammer would greatly add to the life of conventional rock bits.

The air-hammer tool design is adapted for use under various drilling conditions. However, more evaluation is necessary before this tool is generally accepted by the drilling industry.

The tool is designed to operate while mist drilling, but no attempts have been made in the Permian Basin toward evaluating its performance under these conditions. Maintenance of the air hammer is negligible and there are no reports of tool breakage while operating within required volumes and pressures.

All air-hammer drilling covered by this report used the 6¾-in. tool described by Liljestrand.[2]

WELL A: 4114 to 11,330 FT

This well is located in Terrell County, Texas, near the northern limits of the Sheffield Channel. An 8¾-in. hole was drilled from 4114 to 11,330 ft using air as the circulating medium. Through intervals of comparable formation, weight on bit, and rotary speed, air-hammer penetration rates exceeded conventional air-rotary drilling rates 1.5 to 3.8 times.

Deviations remained less than 3½ deg through 4286 ft of hole drilled to a depth of 8700 ft. A sudden unexplained increase in deviation occurred between 8700 and 8800 ft where it was extended to 5¼ deg. Further increases in deviation were recorded to a maximum of 11 deg at 11,200 ft.

No direct comparisons in bit life were made. However, most air-hammer bits were pulled in usable condition. Evidence points to a shorter bit life in terms of hours, but a longer life may be expected in total footage by bits used with the air hammer as compared to air rotary.

Compressed air volumes from 2000 to 2500 cu ft per min with pressures from 125 to 250 psi were utilized in the drilling of this well.

Penetration Rates

The best comparison between air-hammer and air-rotary drilling is best made on the basis of rotating time. This information is tabulated in Table 1 and it is shown graphically in Fig. 1. Air-hammer drilling and conventional air-rotary drilling were used alternately between 4114 and 7462 ft. Through this interval of similar formation and using comparable weight on bits and rotary speed, air-hammer penetration rates were 1.5 times faster than air rotary.

Harder formation was encountered at about 7500 ft drilling with conventional air rotary. With a weight on bit of 10,000 lb, air rotary averaged 19.1 ft per hr. An increase of 17.4 ft per hr or 1.9 times faster than air rotary was recorded through the following air-hammer drilled interval using 15,000 lb weight on bit.

Less than 5000 lb weight on bit was applied through the hammer-drilled section from 9102 to 10,618 ft. Average penetration rate was 32.1 ft per hr. Compared to the following conventional air-drilled rates from 10,618 to 10,973 ft, averaging 8.5 ft per hr, this indicates air-hammer drilling was 3.8 times faster than air rotary with only 2000 lb additional weight on bit.

It should be noted that the hammer drill was in the hole through parts of the above interval considered as conventionally drilled. It is believed that the pressure force on the air-hammer anvil was greater than the weight on bit, thereby placing the tool in a circulating position through this interval and the tool could not hammer. Conventional air-drilling rates resulted and are used for comparison.

This is further substantiated by the following hammer-drill run which averaged 20.8 ft per hr with a weight on bit from 10,000 to 15,000 lb.

Hole Deviation

Hole deviation recorded in this well from 4414 to 8651 ft, or 4237 total ft, contrasts with little difference between air-rotary and air-hammer drilling. This interval has similar conditions of weight on bit, rotary speed, bottom-hole

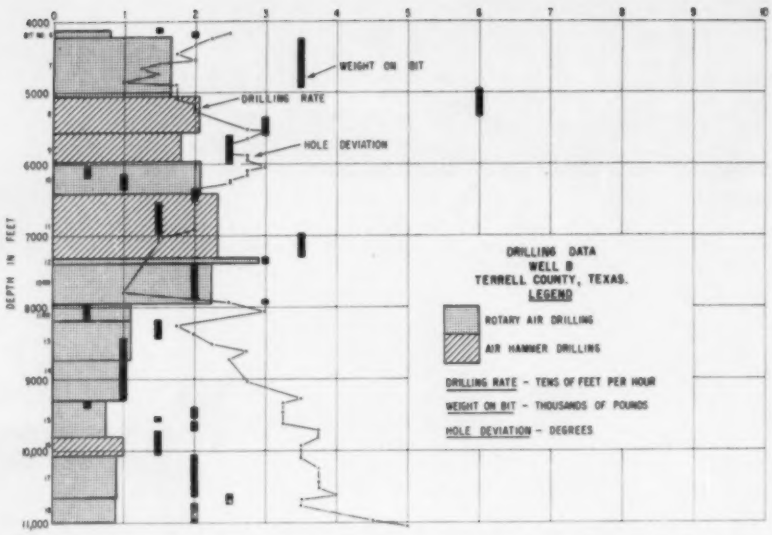

FIG. 2. Another well drilled in Terrell County, Texas, compares rotary air drilling and air-hammer drilling.

Table 2. Drilling Data — Well B.

No.	Bit Type	Depth from-to	Feet	Rotating hours	Penetration rate (ft/hr)	Weight on bit (1000 lb)	Rotary speed (rpm)	Deviation (degrees)
6	Tooth	4,112— 4,216	104	12.50	8.3	1.5 to 2	60	2½
7	Insert	4,216— 5,053	837	50.00	16.7	3 to 4	75 to 80	1 to 1¾
8*	Insert	5,053— 5,457	404	19.50	20.6	3 to 10	65 to 70	1 to 1¾
9*	Insert	5,457— 5,963	506	28.00	18.0	1 to 4	70	2½ to 3
10	Insert	5,963— 6,427	464	19.50	23.8	0 to 2	70	2 to 3
11*	Insert	6,427— 7,319	892	37.00	24.1	0 to 5	70	1½ to 2
12	Insert	7,319— 7,400	81	2.75	29.4	2 to 3	70	—
RR(10)	Insert	7,400— 7,949	549	20.00	22.4	0 to 5	70	1 to 2½
RR(11)	Insert	7,949— 8,180	231	20.75	11.1	0 to 1	70	2¼ to 3
13	Insert	8,180— 8,744	564	49.50	11.4	0 to 3	65	1¾ to 2¾
14	Insert	8,744— 9,292	548	53.50	10.3	0 to 2	65	2¾ to 3½
15	Insert	9,292— 9,802	510	66.50	7.7	0 to 4	65	3¼ to 3¾
16*	Insert	9,802—10,039	237	23.75	10.0	0 to 3	60	3½ to 3¼
17	Insert	10,039—10,640	601	65.50	9.2	0 to 4	60	3½ to 4
18	Insert	10,640—11,006	366	40.25	9.1	0 to 4	65	3½ to 4½
19	Insert	11,006—11,077	71	12.00	5 9	0 to 5	65	5

*Denotes air hammer use
Rotating hours and penetration rate include connection time

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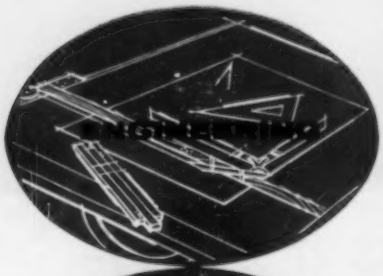

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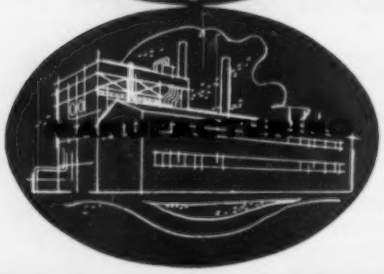

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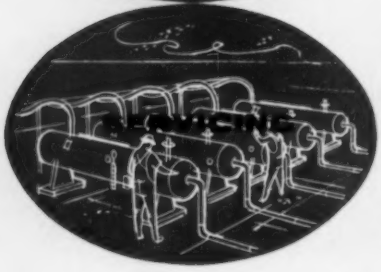

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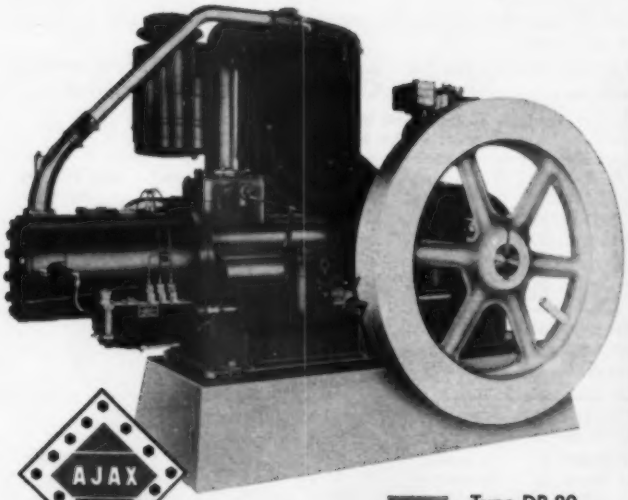

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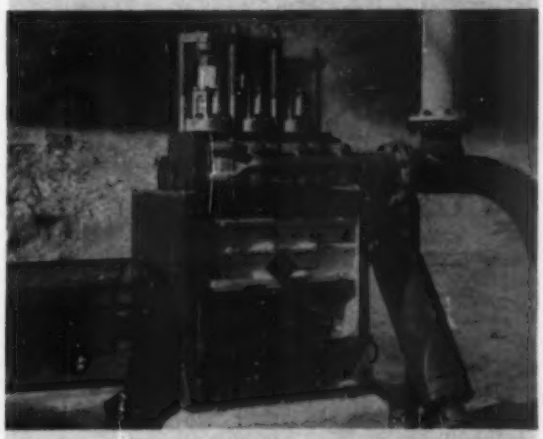

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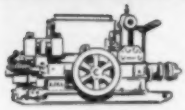

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assembly, hole size, and rock type. Deviations vary from ¼ deg to 3½ deg for a gross change of 2¼ deg and a net change of ¾ deg over the entire interval.

The sudden increase in deviation between 8700 and 8800 ft is unexplained. If this increase is disregarded, however, note that there is no net change in deviation (6¼ deg) through the hammer-drilled interval between 8800 ft and 9900 ft.

Gradual increases in deviation were recorded to a maximum of 11 deg at 10,300 ft. Variations in drift over relatively short intervals are evident through this section and indicate extreme crooked-hole conditions. This is further supported by deviations recorded through the mud-drilled interval from 13,300 to 14,500 ft where deviations increased to 26 deg. Rate of change in deviation per foot drilled was not excessive, however, and casing was successfully landed at total depth.

This well is not considered conclusive in evaluating deviation control with the air hammer. Rather, it indicates an urgent need for more evaluation, particularly in the field of deviation control.

Bit Data

Bit comparison is difficult because many were pulled prematurely to evaluate shows or because of lacking comparative data. Most air-hammer bits of the insert type were pulled still in excellent condition, whereas the standard tooth variety were pulled dull. The short life of standard tooth bits (4, 6, and 12) is shown in Table 1.

Reaming time from 2.5 to 5.0 hours followed bits 3, 4, and 6 — all tooth bits. Short reaming time of less than 1.0 hr followed runs 7 and 8 — both insert-type bits. Further evidence of the superiority of insert type bits is apparent in bit 5, which drilled a total of 1128 ft with the air hammer and 239 ft conventionally.

Comparative data below 7500 ft are considered insufficient to further evaluate bit life between air-rotary and air-hammer drilling in this well.

WELL B: 4112 TO 11,077 FT

Well B is located in Terrell County, Texas, in the Sheffield Channel. Air drilling commenced at 4112 ft and continued to 11,077 ft, with a hole diameter of 8⅝ in. Formations penetrated were essentially soft, unconsolidated shales with occasional sand and carbonate stringers.

Air-hammer drilling averaged 18.2 ft per hr compared to 13.8 ft per hr by air-rotary drilling through the entire air-drilled interval. However, penetration rates were increased as much as 2.8 times over conventional air rotary

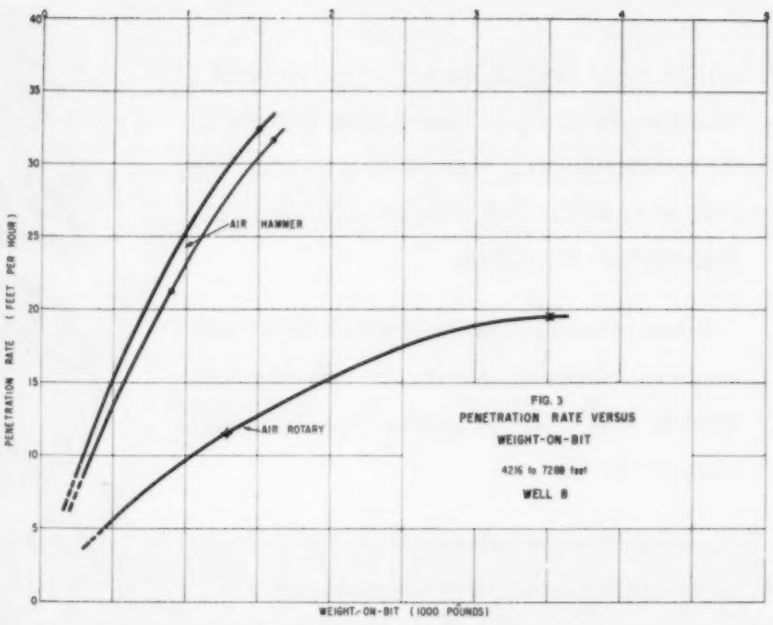

FIG. 3. Penetration rate vs weight on the bit shows that, for the wells considered in this report, the air hammer effectively doubled the rate of penetration of the air rotary.

by use of the air hammer through a 3072-ft section. Bit footages were difficult to compare as nearly all bits were pulled prematurely.

Hole deviation remained between 1 and 3 deg through the test interval drilled alternately by air-hammer and air-rotary methods, although deviation was extended to 5 deg while drilling principally with air rotary.

Compressed air for drilling was furnished by 5 two-stage, single-acting air compressors with pressures available up to 350 psi and volumes up to 2375 cu ft per min. Air consumption was not measured.

A special float valve gave good service in this well and is recommended for use with the air hammer. A new top-hole flapper valve float also performed excellently.

A plot of drilling rate based on ro-

Table 3. Comparison of Penetration Rates Air Hammer vs Air Rotary — Well B.

Interval drilled, (ft)	Feet	Drilling method	Penetration rate,* ft/hr	Avg. wt on bit (1000 lb)
4216—5053	837	Air rotary	18.4	3.52
5053—5457	404	Air hammer	31.6	1.58
5457—5963	506	Air hammer	21.2	.91
5963—6407	444	Air rotary	11.4	1.30
6407—7288	845	Air hammer	32.4	1.50

*Penetration rate calculated from actual rotating time

Table 4. Bit Footages Obtained in Well B.

Bit No.	Type	Drilling method	Feet	Rotating hours	Why pulled
11	Insert	Air hammer	892	37.0	Check air hammer
7	Insert	Air rotary	837	50.0	Wire line broke
17	Insert	Air rotary	601	65.5	Hours rotated
13	Insert	Air rotary	564	49.5	Hours rotated
RR	(No. 10)	Air rotary	549	20.0	Dull
14	Insert	Air rotary	548	53.5	Hours rotated
15	Insert	Air rotary	510	66.5	Hours rotated
9	Insert	Air hammer	506	28.0	Adjust air hammer
10	Insert	Air rotary	464	19.5	Twist-off
8	Insert	Air hammer	404	19.5	Change bottom-hole assembly
18	Insert	Air rotary	366	40.25	Twist-off
16	Insert	Air hammer	237	23.75	Hole condition
RR	(No. 11)	Air rotary	231	20.75	Hours on bit (dull)
6	Tooth	Air rotary	104	12.5	Twist-off
12	Insert	Air rotary	81	2.75	Plugged air hammer
19	Insert	Air rotary	71	12.0	Twist-off

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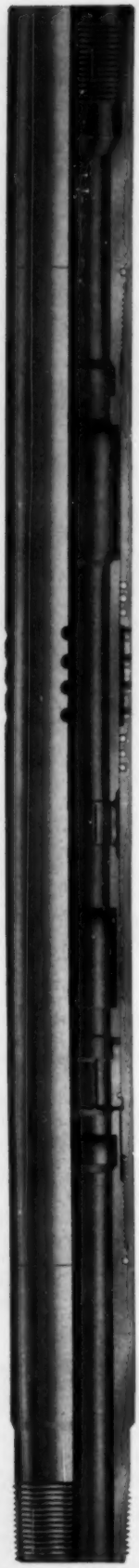

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tating time, weight on bit, and hole deviation vs hole depth is shown in Fig. 2. Drilling data through the air drilled interval are presented in Table 2.

Rate of Penetration

Referring to data in Table 3 and Fig. 3, it may be seen that the use of the air hammer increased penetration rates from 1.8 to 2.8 times over conventional air rotary with reduced or nearly equal weight on bit.

Comparison of drilling rates from 9802 to 11,006 ft is not made because of lacking comparative data. From data in Table 3, it may be noted that average weight on bit is very low when compared to normal air-rotary drilling. This points out the need for accurate weight indication, best produced by an automatic driller.

Hole Deviation

Deviations in this well through the air-drilled portion ranged from 2½ deg at 4189 ft to 5 deg at 11,061 ft.

Through the interval where alternate drilling methods were used (4112 to 7319 ft), decreases in deviation from 2½ to 1½ deg were recorded. Air-hammer drilling was used to drill 1802 ft and air rotary was used to drill 1425 ft through this interval.

Conventional air rotary was used to drill 3758 ft from 7319 ft to 11,077 ft, except for 237 ft between 9802 and 10,039 ft. A sharp increase in deviation was noted from 1 deg at 7799 ft to 3 deg at 8063 ft. A gradual increase in deviation was recorded to a maximum of 5 deg at 11,061 ft through the air-rotary drilled hole.

Bit Data

It may be seen by the tabulations in Table 4 that valid comparison of bit life is difficult in this well. Many bits were pulled prematurely because of mechanical problems and were considered capable of re-running.

Bit 10 logged 1013 ft on 2 runs, drilling conventionally with air. Bit 11 drilled 892 ft with the air hammer and 231 ft conventionally, for a total of 1123 ft.

Table 5. Drilling Data, El Mar Field, Loving County, Texas.

	Bit data No.	Type	Feet drilled	Rotating hours	Feet per rotating hr	Deviation deg
Well X.....	1	Tooth	1853	31.75	58.0	1 to 4¼
	2	Tooth	655	40.50	16.2	4¼
	3	Tooth	742	23.50	31.6	4
Well Y.....	1	Tooth	1887	30.0	63.0	¾ to 1¾
	2	Tooth	455	18.75	24.2	3 to 3¾
	3	Tooth	855	39.0	39.0	3¼ to 4
Well C.....	1*	Tooth	1446	21.0	68.9	¾ to 1
	2*	Tooth	1617	34.25	47.3	1¾ to 2¼
	3	Tooth	149	6.0	24.8	—
Well D.....	1	Tooth	1490	17.25	86.5	½ to ¾
	2*	Tooth	333	20.0	41.6	2 to 3
	3	Tooth	919	16.25	56.5	2
Well E.....	1	Tooth	1495	19.5	76.8	1
	2*	Tooth	777	18.0	43.2	¼ to 1
	3	Tooth	543	9.5	52.3	1

*Denotes air hammer use

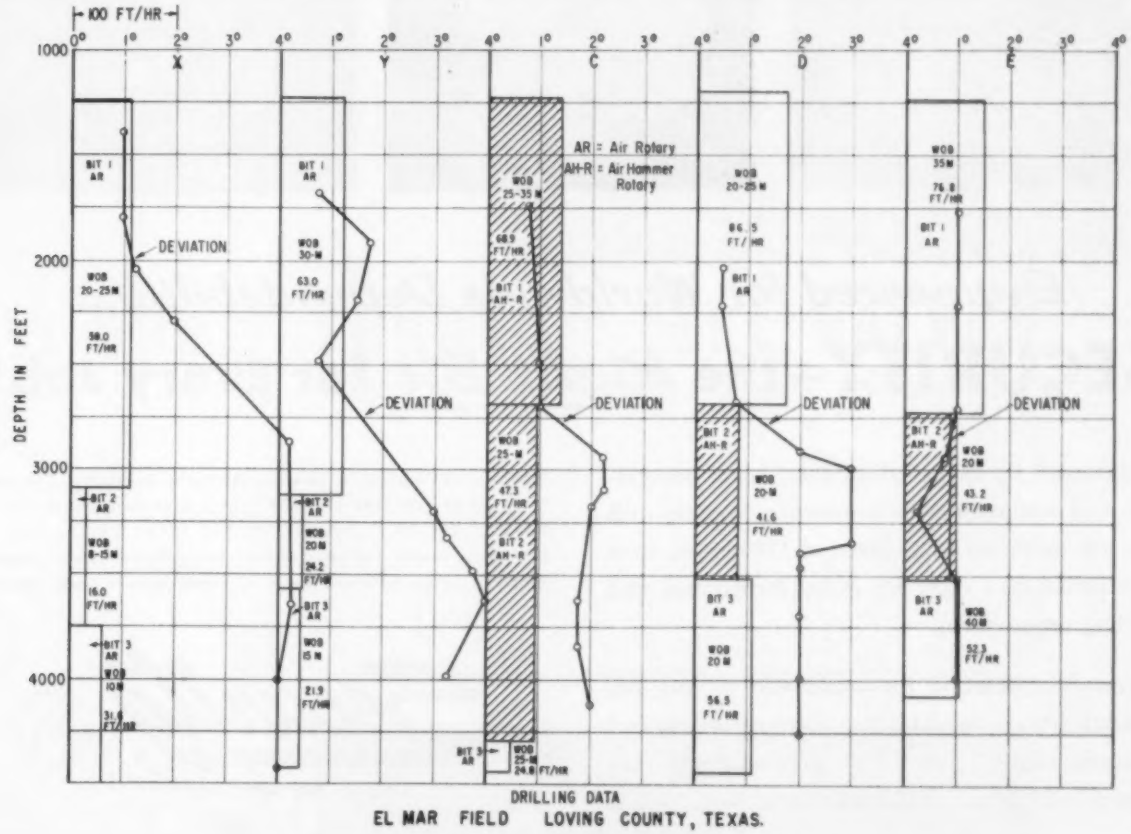
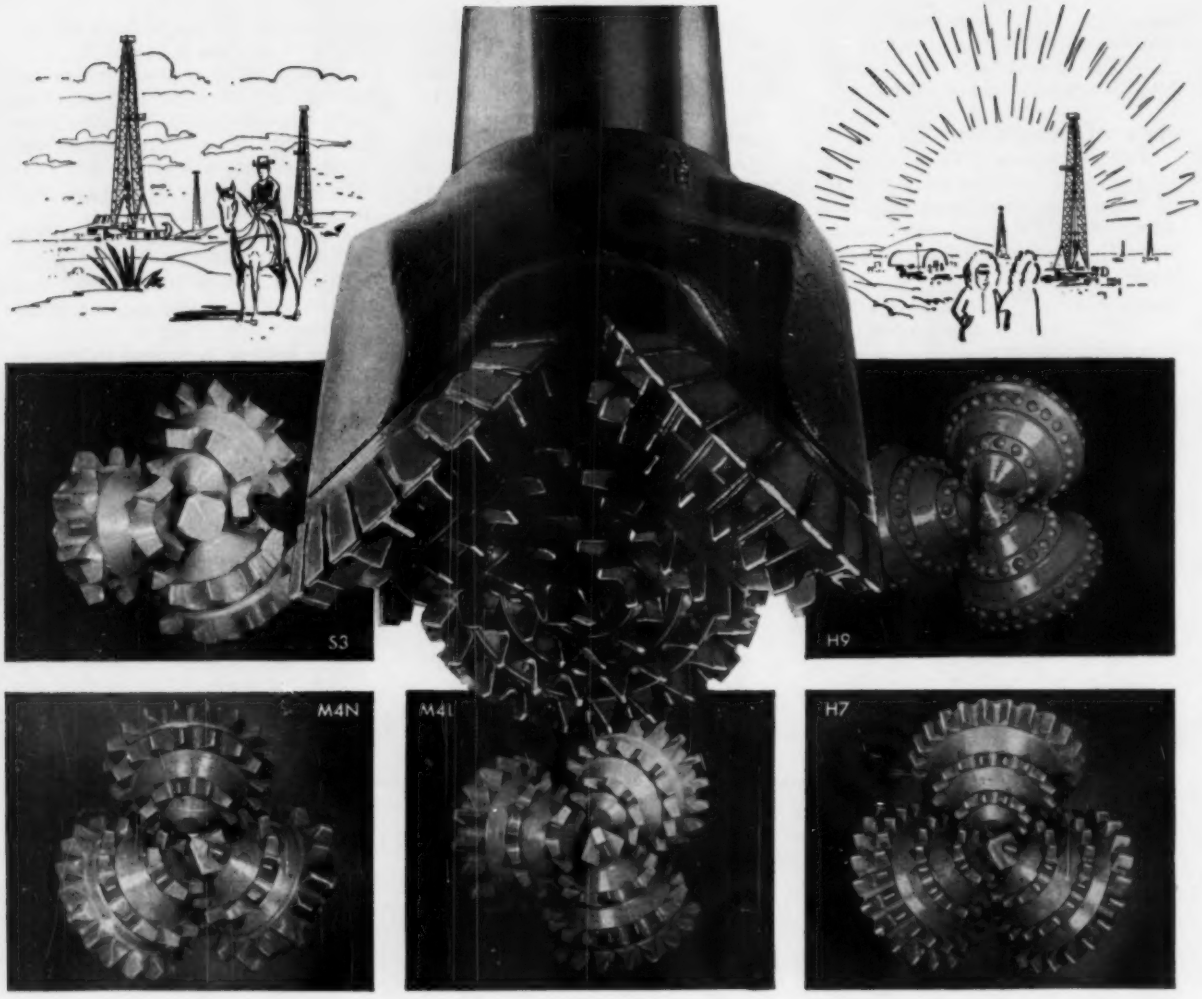


FIG. 4. Five wells drilled in El Mar field of Loving County, Texas, show performance of air-hammer drill in Wells C, D, and E.



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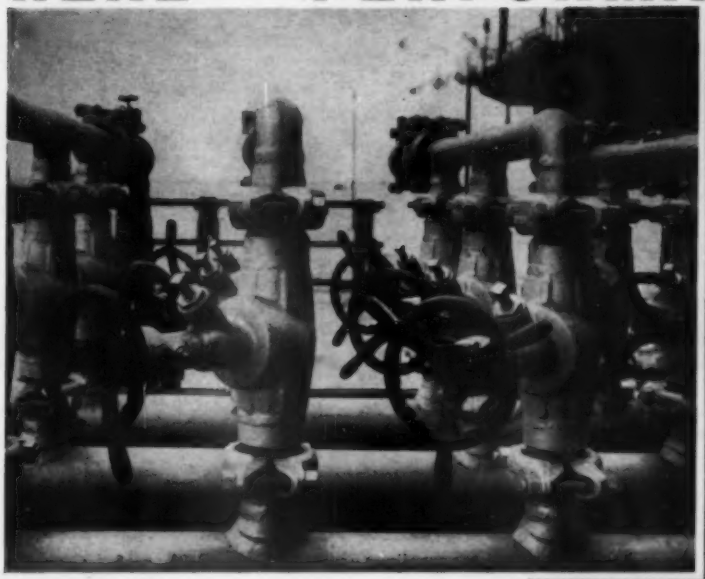

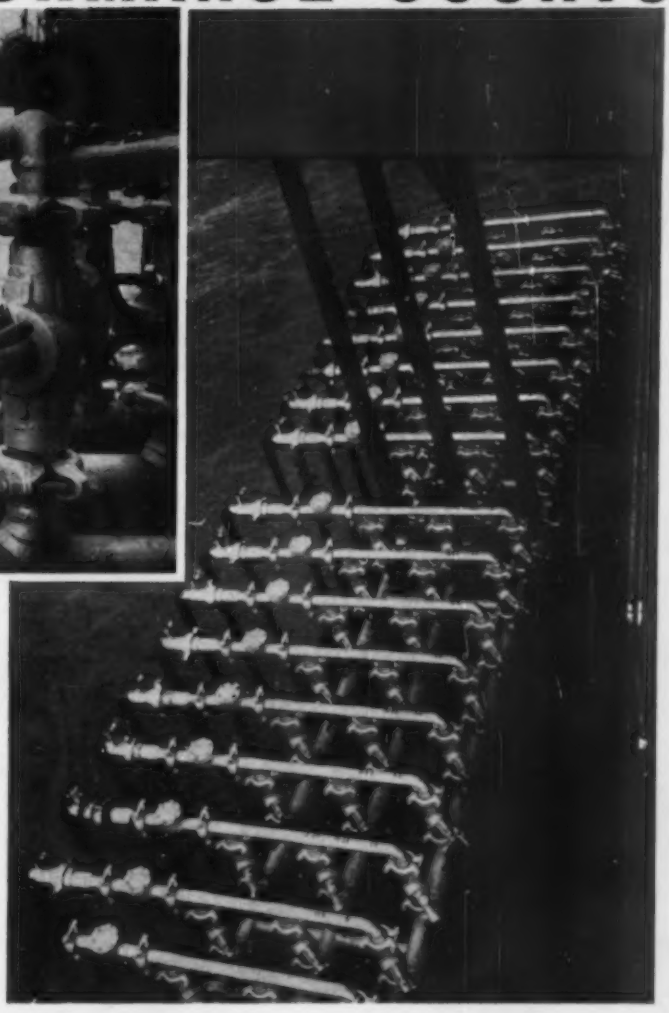

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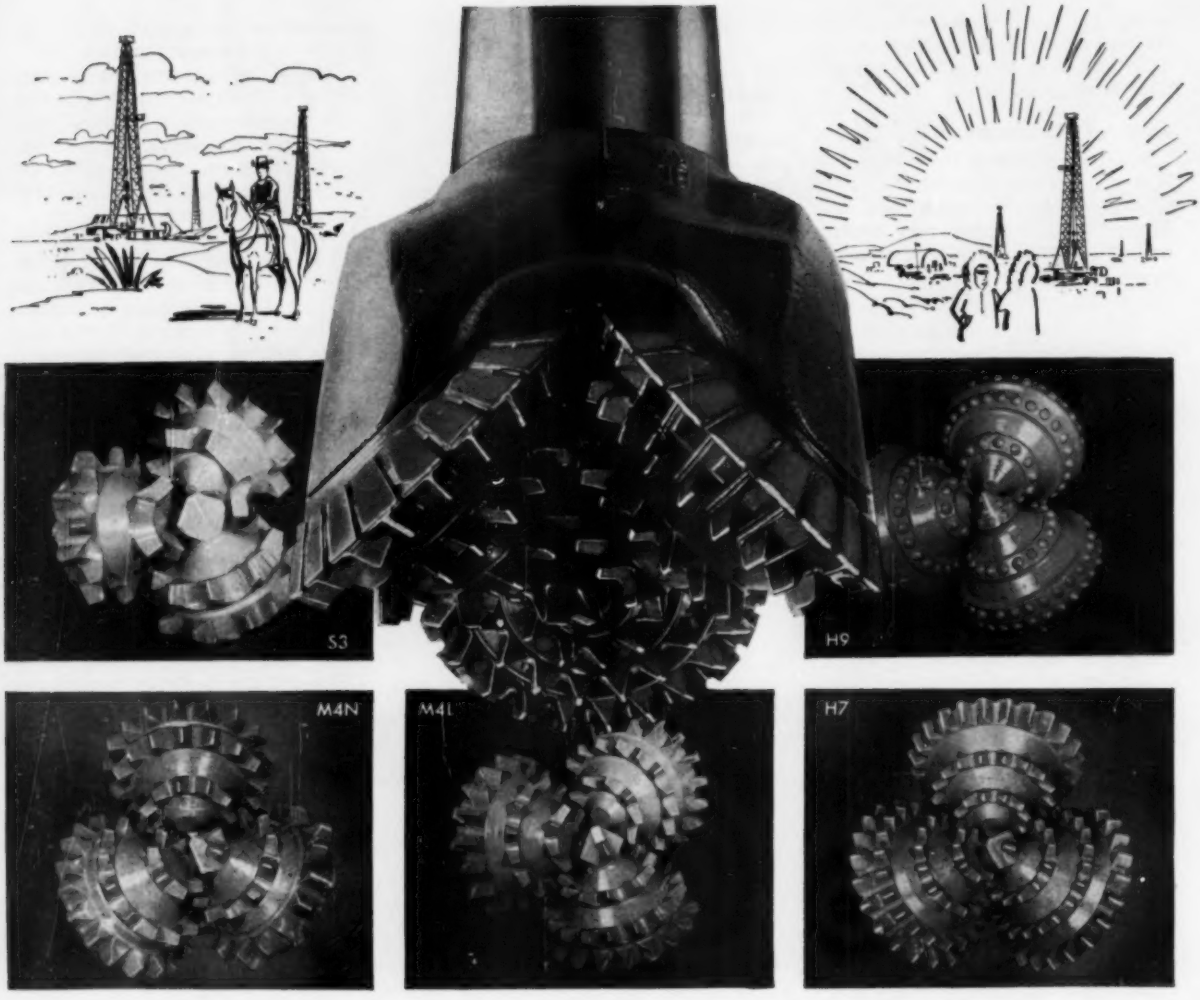

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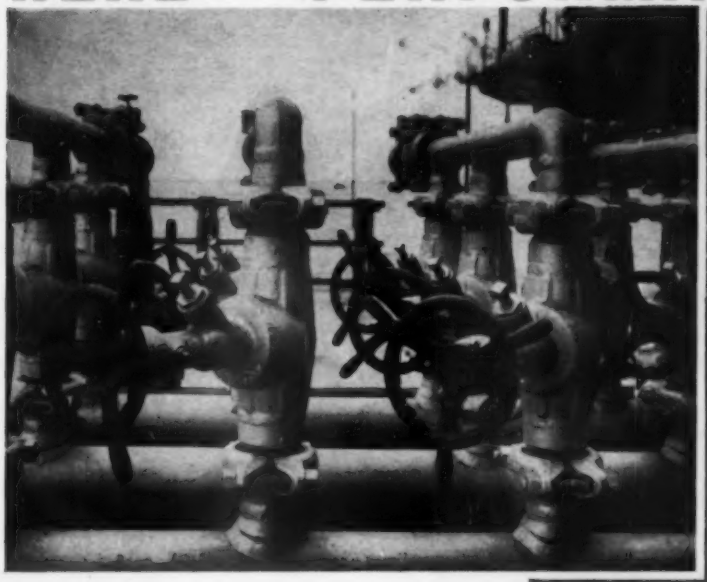

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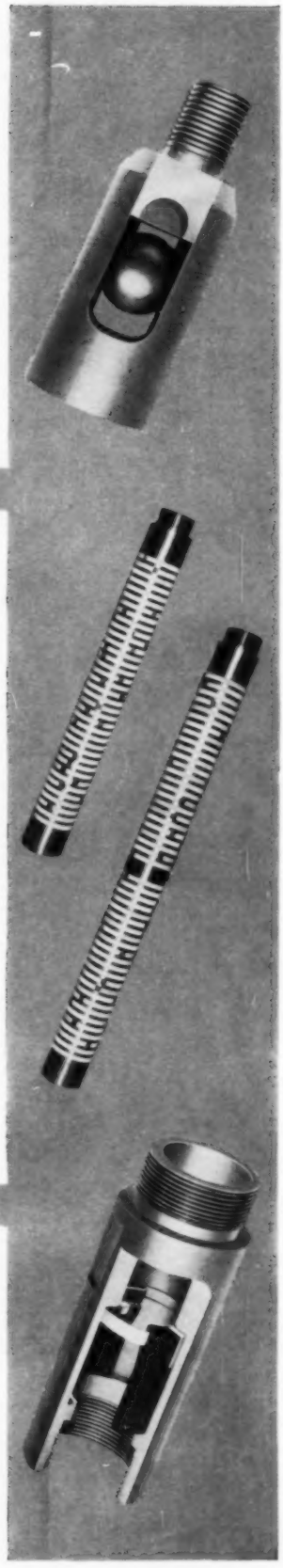

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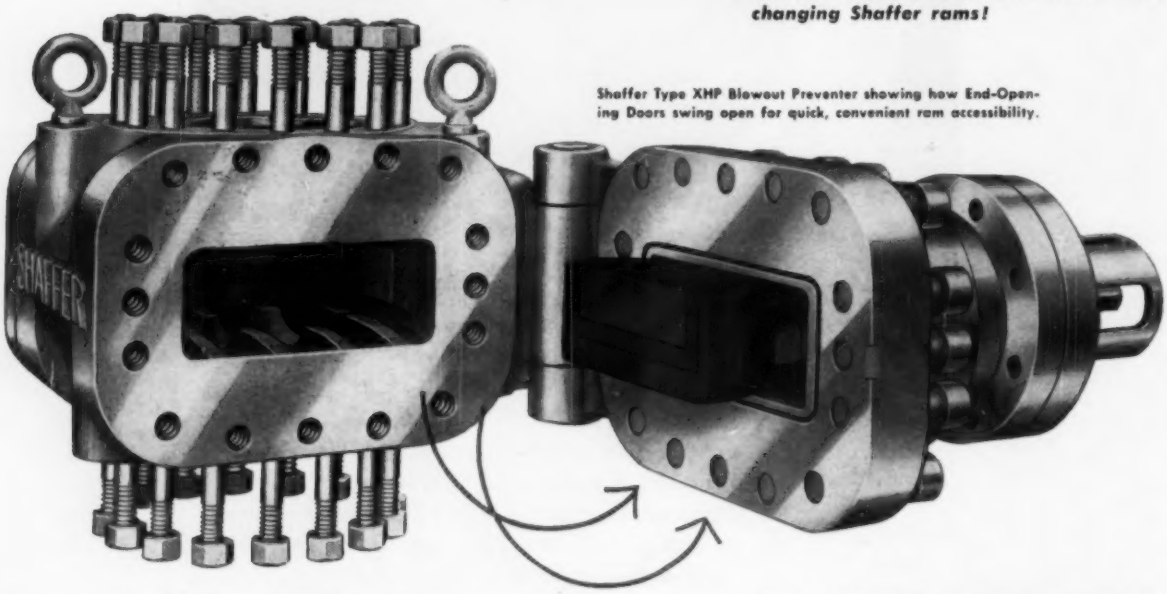

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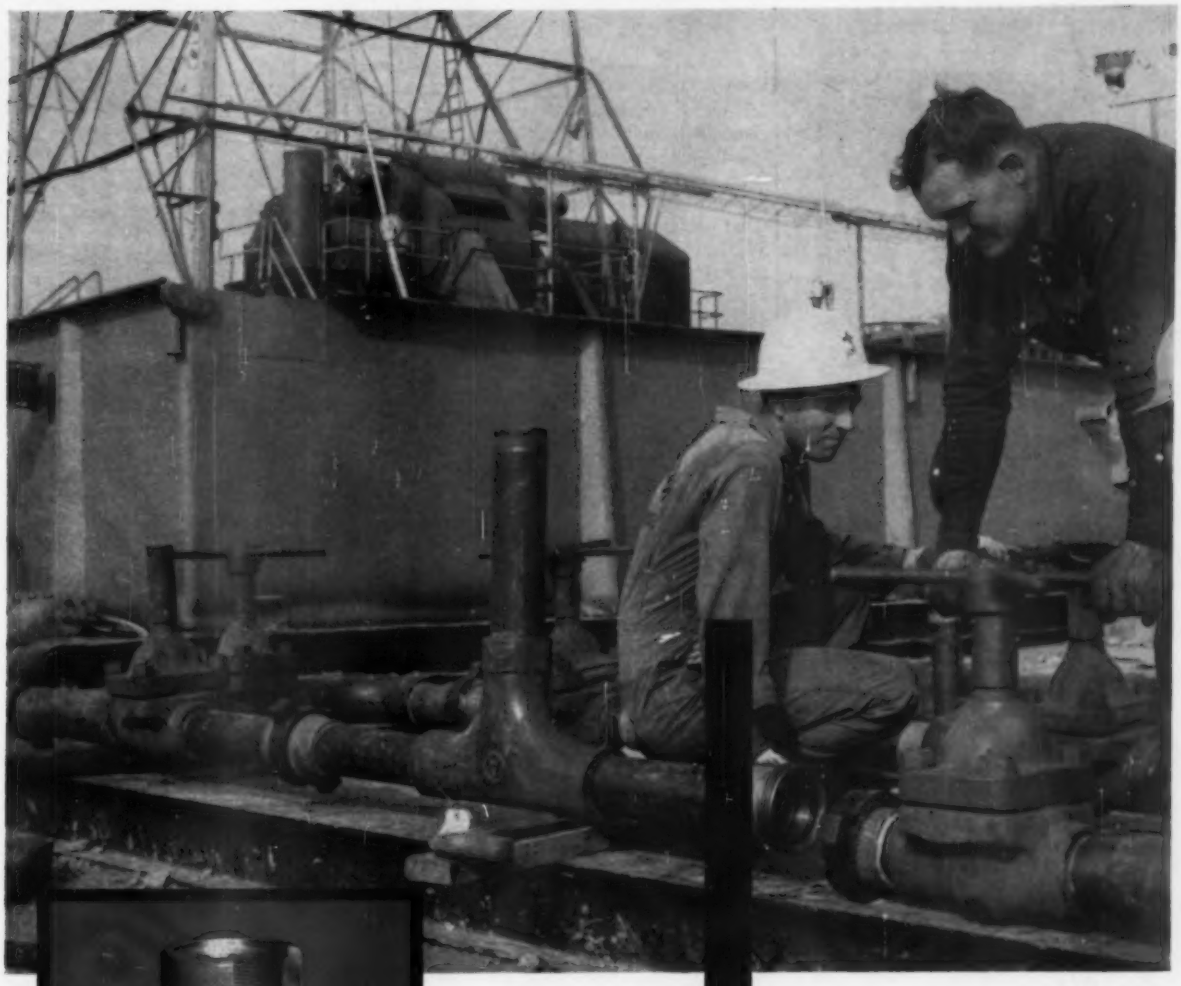

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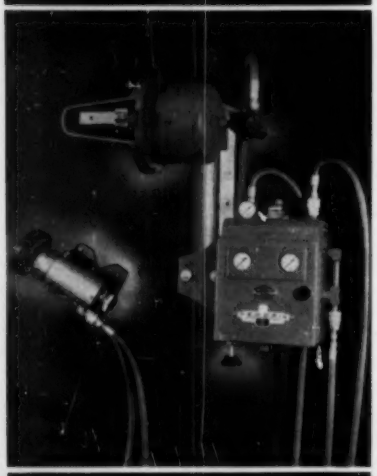

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WELLS C, D, AND E

These wells are closely spaced in the El Mar field, Loving County, Texas, and are compared to conventionally air-drilled wells. The average depth usually drilled with air is about 4400 ft from surface casing set at approximately 1225 ft. Formations encountered are typically evaporites with anhydrite predominating. Salt is present throughout the column in lesser amounts, but certain beds may exceed 250 ft in thickness from 3500 to 4150 ft.

Air-hammer drilling was used in Wells C, D, and E in an effort to control excessive hole deviation usually occurring between 2700 and 3500 ft and to maintain a high penetration rate.

The 6¾-in. tool was used with 7⅞-in. specially adapted hammer bits of the hard-formation type. Air volumes varied from 1425 cu ft per min with air rotary to 1800 cu ft per min with the air hammer. Standpipe pressures were 100 to 125 psi during conventional air drilling and ranged from 225 to 250 psi with the air hammer.

Reference to Fig. 4 and Table 5 shows that the average penetration rate with air rotary through the crooked-hole interval is about 20.0 ft per hr with deviations exceeding 4 deg. Four degrees is the contract limit in many cases.

Fig. 4 and Table 5 also indicate that the deviation was held to a 3-deg maximum and were recorded as low as ¼ deg through this interval while using the air hammer. Comparable weights on bit of 20,000 lb were used and the rotary turned at 60 rpm in most wells. Air-hammer penetration rates were increased from about 20.0 ft per hr to an average of about 40 ft per hr, or double that of air rotary.

Well C indicates bit footages may be doubled by comparison to conventionally air-rotary drilling. Bits used while hammer drilling in Wells D and E experienced failure or plugging and fishing jobs resulted in both wells.

It may be concluded that air-hammer drilling in these wells exhibited two times averaged penetration rates, considerably reduced deviation, and bit life was extended by twice that of air rotary.

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What's doing in DRILLING

Scouts Report 2432 Rigs Operating in United States

Active rotary rigs and cable tool rigs in the United States stand at 2121 rotary and 311 cable tool, totaling 2432 rigs, according to the International Oil Scouts Association report on April 22 to the American Association of Oilwell Drilling Contractors.

Data includes all rigs from rigging up to tearing down stage, including those drilling, logging, testing, cementing, fishing, or temporarily shutdown. There were no reports included from North Arkansas, Florida, Georgia, East Kansas, New York, Ohio, Pennsylvania, Tennessee, and West Virginia.

Improved Drilling Rates, Cost Reduction Obtained

Improved drilling rates and reduced drilling costs have been obtained through careful utilization of known drilling concepts, K. F. Swenson and H. G. Schmidt of the Humble Oil and Refining Company, Carter Division, reported.

The two Humble men reported at the Rocky Mountain Division meeting of the American Petroleum Institute that data for their report was gleaned from five wells drilled by their company in the North Tioga pool in North Dakota using known techniques that included jet bits and low-viscosity mud with improved rig hydraulics.

Using two of the five wells drilled prior to 1959 as a basis for comparison with wells drilled in 1959, the techniques mentioned resulted in a 43 percent reduction in drilling time from 19.8 days per well to 11.3 drilling days per well.

They indicated that, as a result of the successful application of jet bits and a low-solids, low-viscosity mud in the field, it has been possible to apply these principles to other areas of operation with similar success. They further emphasized that each well and area had to be evaluated on its own to support somewhat drastic changes in drilling techniques.

However, the results in each case where these improved drilling practices have been applied have been a substantial reduction in the number of rotating hours required to reach total depth, with a resultant decrease in the overall direct cost of the well.

Prior to 1959, the cost of a North Tioga field well was $73,000, whereas they can now be drilled for $47,000, a reduction of 36 percent.

Swenson and Schmidt explained in detail operations conducted on the five wells and urged closer cooperation between producer and contractor in relation to improved techniques to reduce time and costs per well drilled.

Company Increases Footage With Deep Drilling Policy

Falcon Seaboard Drilling Company of Tulsa has reversed the downward trend in its operations with a policy that could be called "digging deeper."

Falcon adopted its new policy in mid-1958, but put it into full effect last year.

Policy called for liquidation of shallow capacity equipment and the acquisition of rigs with greater drilling capabilities. Company had to make an additional investment, but it could drill deeper holes.

There were two reasons for the decision, Theo N. Law, Falcon Seaboard president, said.

While competition is ruinous on shallower wells, there are relatively few rigs capable of drilling the real deep ventures anywhere except on the Gulf Coast, he said.

Second, deeper rigs are on location longer, which means moving costs are less and good crewmen can be retained.

"It's better to bid against three other contractors than 30 of them," Law said, "especially when you can keep a good crew together."

"We have some shallow production, but we don't do our own drilling," Law said. "We contract it out to somebody else. It's cheaper."

Extent of Falcon's change is reflected in its equipment used in the Mid-Continent area.

This year Falcon has 20 rigs operating, 15 of which can drill below 10,000 ft and 5 below 15,000 ft.

During the previous year, Falcon rigs operated 73 percent of the time compared to 61 percent previously. Completed drilling contracts totaled 151 wells compared to 113 in 1958.

Gross footage drilled equalled 1,145,132 ft, compared to 1,009,526 ft the previous year. Six wells were drilled to depths below 15,000 ft, including an 18,550 ft southwest Texas venture which was the deepest hole ever drilled with air.

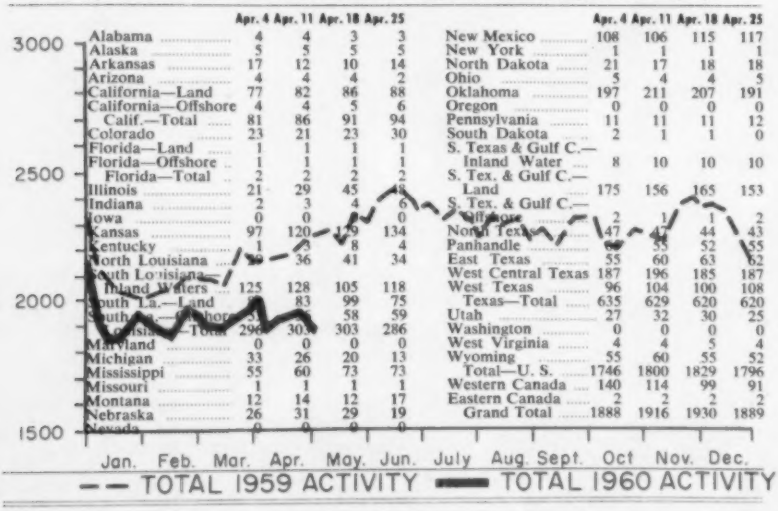
Gross income from domestic operations jumped more than $2.75 million over the previous year.

Although they are relatively satisfied with this progress, the company intends to step up the pace, Law said.

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oil Well Drilling Contractors by Hughes Tool Company.

	Apr. 4	Apr. 11	Apr. 18	Apr. 25
Alabama	4	4	3	3
Alaska	5	5	5	5
Arkansas	17	12	10	14
Arizona	4	4	4	2
California—Land	77	82	86	88
California—Offshore	4	4	5	6
Calif.—Total	81	86	91	94
Colorado	23	21	23	30
Florida—Land	1	1	1	1
Florida—Offshore	1	1	1	1
Florida—Total	2	2	2	2
Illinois	21	29	45	48
Indiana	2	3	4	6
Iowa	0	0	0	0
Kansas	97	120	129	134
Kentucky	1	2	8	4
North Louisiana	39	36	41	34
South Louisiana—				
Inland Waters	125	128	105	118
South La.—Land	83	83	99	75
South La.—Offshore	58	58	58	59
Louisiana—Total	296	303	303	286
Maryland	0	0	0	0
Michigan	33	26	20	13
Mississippi	55	60	73	73
Missouri	1	1	1	1
Montana	12	14	12	17
Nebraska	26	31	29	19
Nevada	0	0	0	0
New Mexico	108	106	115	117
New York	1	1	1	1
North Dakota	21	17	18	18
Ohio	5	4	4	5
Oklahoma	197	211	207	191
Oregon	0	0	0	0
Pennsylvania	11	11	11	12
South Dakota	2	1	1	0
S. Texas & Gulf C.—				
Inland Water	8	10	10	10
S. Tex. & Gulf C.—				
Land	175	156	165	153
S. Tex. & Gulf C.—				
Offshore	2	1	1	2
North Texas	47	47	44	43
Panhandle	60	55	52	55
East Texas	55	60	63	62
West Central Texas	187	196	185	187
West Texas	96	104	100	108
Texas—Total	635	629	620	620
Utah	27	32	30	25
Washington	0	0	0	0
West Virginia	4	4	5	4
Wyoming	55	60	55	52
Total—U. S.	1746	1800	1829	1796
Western Canada	140	114	99	91
Eastern Canada	2	2	2	2
Grand Total	1888	1916	1930	1889



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Almost all fracturing sand furnished by Halliburton is ordered and delivered in bulk form. Customers like the greater convenience – without waste from sack breakage – without time lost in sack handling. This popular method of bulk sand delivery means a busy schedule for the fifty strategically located Halliburton Bulk Material Plants. You'll find one just minutes away from your well.

Cash in on this measured value of service from Halliburton. Call your local Halliburton Representative on your next fracturing job.

An important element in the operation of every Halliburton Bulk Material Plant is the accurate weighing mechanism. The Halliburton man posted at the indicator is there to help see that you *get full measure* for your investment in fracturing sand.

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"THE RIGHT WEIGH IS THE HALLIBURTON WAY"

Fishing Operation Cleans Junk From Bad Hole

A bad hole on Ada Oil Company Nevenheim No. 1 well at Dumas, Texas, has been successfully cleaned.

Trouble occurred when a string of 4½ in., 9½ lb casing was being run inside of the 7 in. casing to shut off water. Casing was set after being run to 3370 ft and was to be cemented to the surface using 440 sacks of cement.

While plug was being pumped down, the 4½ in. casing parted at the first collar below the surface, allowing the string to drop 190 ft. About 15 bbl of cement remained inside the casing.

Operator called C. N. "Shorty" Hughes, manager of the Borger branch of the Great Bend Fishing Tool Company on the job. Oadus White, service engineer, was placed in direct charge of the fishing operation under supervision of E. L. "Pat" Paterson, production superintendent for Ada.

The 4½ in. casing was removed down to 2593 ft using a casing spear and jars, leaving about 950 ft of badly corkscrewed 4½ in. casing which was full of cement inside as well as in the annulus.

Remaining casing was removed by washing over with 6 in. insert wash pipe and using washover shoes. During fishing operations, the 6 in. wash pipe became stuck. After recovery of all but two joints of the 6 in. wash pipe by use of a spear and jars, the remaining wash pipe was milled up with a special pilot mill.

Hazards of the fishing operations increased at various times because of the loss of circulation and large amounts of iron cuttings in the hole. After hole had been cleaned and a new string of 4½ in. casing was run and cemented, casing had to be perforated and squeezed to bring the cement to the surface.

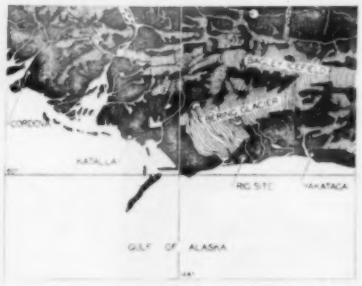
During the fishing operation, 30 rotary shoes and three pilot mills were used. Average footage made for each shoe was over 30 ft. Individual shoes made from 3 to 70 ft of hole.

Remote Alaskan Location Poses Unique Problems

In a remote Alaskan location surrounded by mountains, glaciers, and the sea, where there are only about 2½ hours of daylight in 24, and where there is an annual rainfall of 180 in., crewmen for Clyde Hall Drilling Company of Bakersfield, California, are drilling a well.

Using a rig that is partially enclosed for protection against high, frigid winds, they live in a camp a few miles from the drilling location, but have an emergency crewhouse at the site in case it is needed. All food and fuel oil are flown in.

Well drilling is near Yakataga, along the Gulf of Alaska in Southern Alaska. Location is two miles inland from the gulf, and five miles from the face of



the Bering glacier. Well was spudded in after five months of preparation and expenditure of $1,500,000. Rains, which started two weeks earlier than usual, caused a 2½ month delay in the project.

Rig and much special equipment were brought 3500 miles from Los Angeles, California. The overwater move was made in two LSM's and an LST. Loads were carried across Yakataga Bay in two LSM's. Rig road leads 23 miles to the drilling location.

Rig was given a test run at the drilling company's headquarters at Bakersfield before shipment, allowing rig-up on location in Alaska in only one week.

Entire rig, including mud tanks and pump manifolding, is located in a compact space 50 by 100 ft, which is enclosed on all four sides with carefully-designed steel panels as protection against the weather.

Engines and drive group are equipped with hydraulic couplings, which because of their scoop control serve as engine clutches. An auxiliary drawworks drive provides additional efficiency and ease in operating the rig.

Careful selection of equipment was essential, because during the winter, when storms close the shore for water transportation, all needed supplies must be flown in from Cordova, 100 miles away, where the harbor facilities can be used all year.

Fuel oil for the rig is flown in by C-47 tanker plane, with a capacity of 2000 gal. It is temporarily pumped into a rubber storage bag with a capacity of 10,000 gal located near the runway. Trucks carry the fuel to steel tanks and later to another rubber storage bag at the rig site. Rig normally uses about 1000 gal of fuel each day.

Much of the road is built on muskeg, which provides a firm foundation only when frozen. During the building of the road, some trees, when pushed by a bulldozer, simply moved to one side instead of falling, and continued to grow in the marsh-like ooze. Much of the gravel used in forming the road sank into the muskeg.

For self-sufficiency, a cementing unit, mud-logging unit, and surveying unit are kept at the location. When required, additional service company personnel for operation of these units are flown in from Anchorage.

Italian Government Plans Program Using Mobile Drilling Platform Built in Italy

Italian government plans to step up its offshore oil drilling program with a new mobile drilling platform to be built in Italy with key component parts and technical guidance to be furnished by R. G. LeTourneau, Inc., of Longview, Texas.

According to R. L. LeTourneau, vice president of the firm, who announced the $1,000,000 contract, the giant three-legged platform will be assembled by Nuovo Pignone, an affiliate of Ente Nazionale Idrocarburi (ENI), the government owned oil company. Possibilities of assembling additional platforms in Italy will be explored after completion of this one unit in 1961.

This unit, the largest LeTourneau type platform ever built, will be constructed at Nuovo Pignone's plant at Massa on the north coast of Tuscany and at the nearby port of Marina di Carrara. After completion, it will be turned over to SAIPEM, another affiliate of ENI, for operation. The ultimate destination of the platform has not been announced, however, the ENI group now holds concessions in the Mediterranean, the Adriatic and the Persian Gulf.

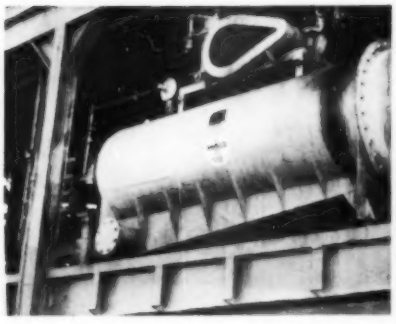
It will be the second mobile platform operated by ENI. The first was built by LeTourneau at its Vicksburg, Mississippi, plant and towed to Italy. It has been in operation for almost a year in ENI's successful drilling program off the coast of Sicily.

New self-contained platform will be about twice the size of the earlier, tender-assisted unit now operated by SAIPEM. Besides complete drilling equipment, it will also contain living quarters for a crew of 50 men and will provide enough storage facilities to enable it to operate in remote areas without frequent deliveries from supply boats.

New feature that will appear on the Italian unit is an electronic sensing device that sounds an alarm if the platform should settle out of level due to abnormal bottom conditions.

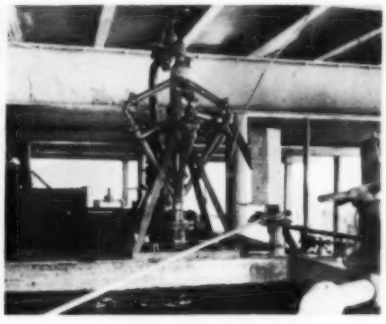
Three good ways to cut drilling costs

The three units shown here are important items behind the recent revolution in drilling fluids that has done so much to speed drilling and cut costs. Each is designed for a different problem but all are efficient and economical. Equally important, all are handled by SWACO -- the leader in mud-treating equipment.



SWACO D-GASSER®

Operators frequently report saving the entire rental cost of a D-Gasser on a well in less than a day.
When mud is gas-cut, the D-Gasser saves money in many ways. It cuts time lost for circulating after trips. It reduces barite costs, it minimizes lost circulation costs and problems. It maintains mud pump efficiency and it actually makes possible the close control of mud weight and viscosity that results in faster drilling with increased safety.



CLAYJECTOR®

If you are using mud as heavy as 12 pounds per gallon, you can cut mud costs and increase drilling rate by using a Clayjector. This is a cyclone-type separation unit that is extremely effective at rejecting unwanted clays and retaining expensive barite.
In addition, since it makes possible the economical maintenance of a low-solids, low-viscosity mud, it actually permits a reduction in bit costs and drilling time.

D-SANDER®

The D-Sander greatly increases the life of mud pump parts and bits when sand or abrasive shale is being drilled. Since it removes virtually all sand-sized solids from the mud, excessive pump-parts and bit-nozzle wear — as well as many other problems — are avoided when a D-Sander is used. There is a size and type to fit every rig and drilling condition.

These descriptions tell just a few of the many ways you can cut costs by mechanical mud treating. For the full story on how you can profit, call your nearest SWACO representative or write us direct.

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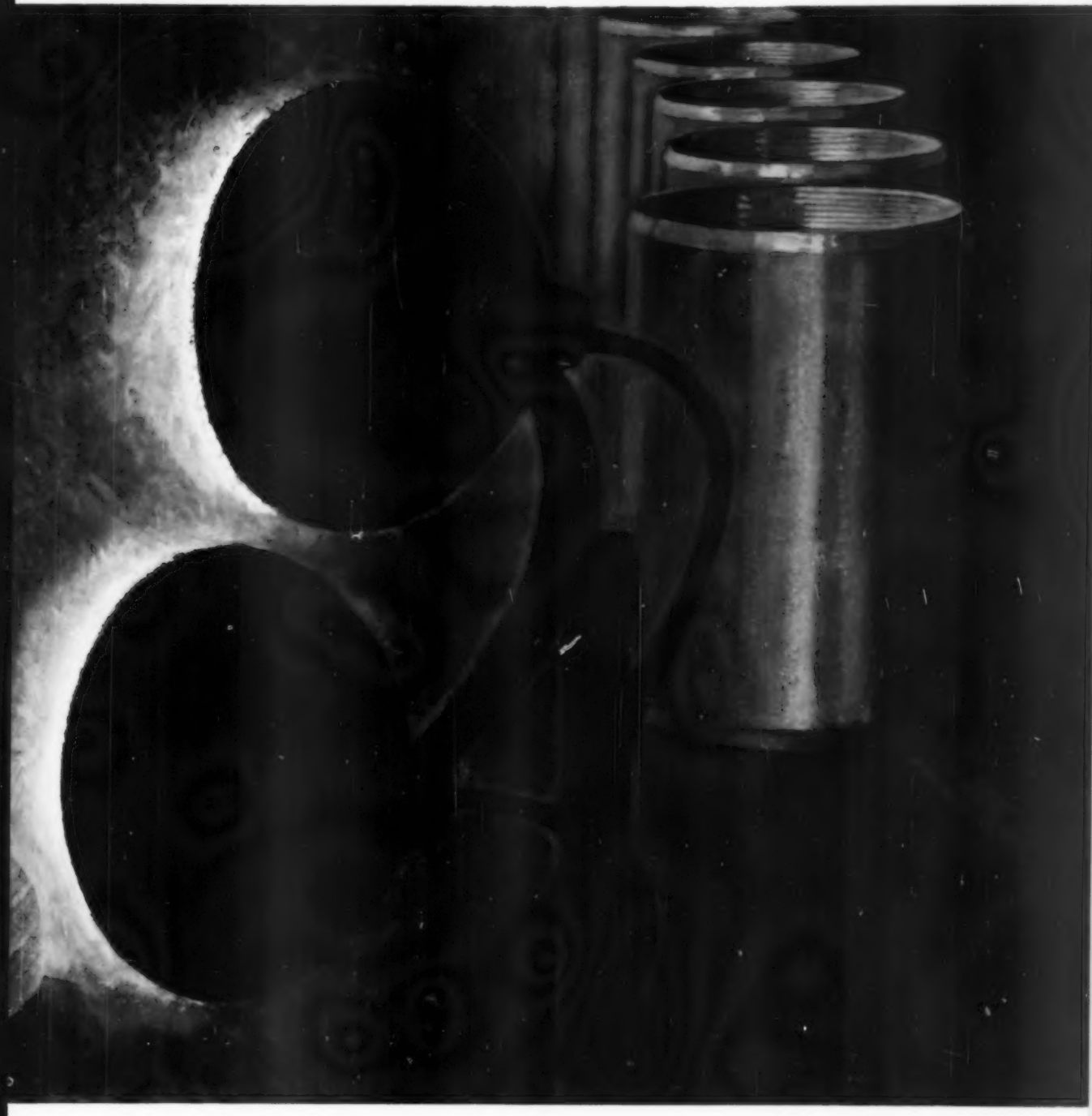
FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Look what's getting the 3rd degree

Illuminated by the weird glow of two powerful ultra-violet lamps, this casing coupling is sweating out a check for possible imperfections. It's a process known as Magnaglo inspection. Here a special-clearance coupling is being inspected.

The coupling is magnetized; then drenched with a reddish-brown solution that contains magnetic particles coated with fluorescent dye. If there is a surface defect on the coupling, fluorescent particles cling to it—held by the magnetic field which builds up around any imperfection in the steel.

The inspector then slowly rotates the coupling on a potter's wheel. He scans it carefully for any tell-tale



gleam that clearly indicates an imperfection.

Magnaglo inspection is only one of the many quality control methods used by National Tube during the production of USS National Seamless Oil Country Tubular Products. If you've got a tough oil country tubular problem, write National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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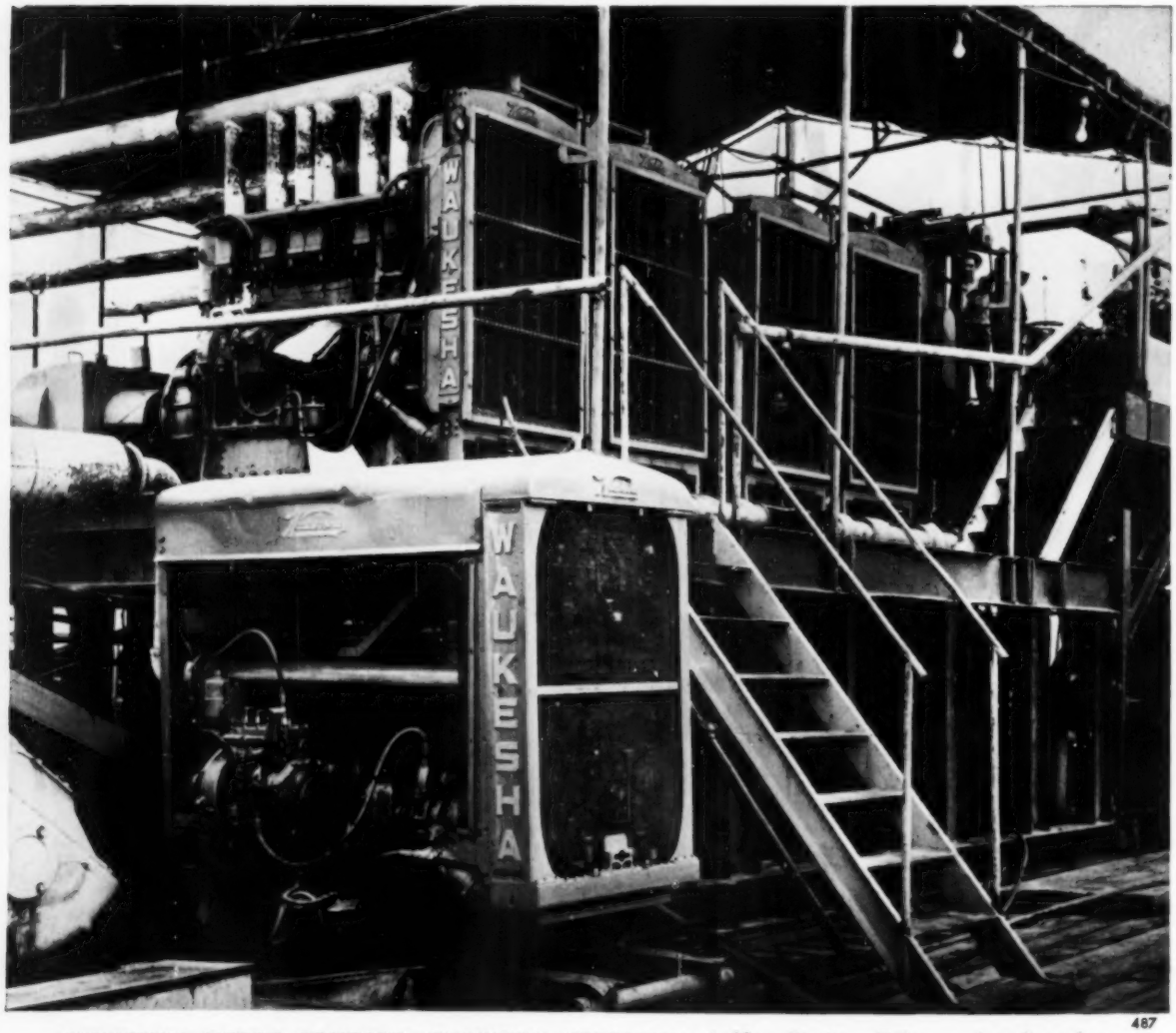
WAUKESHAS ...here and everywhere in the oil fields

The STANDOUTS—in any oil field, on any job—are always Waukeshas! Here, for instance—at Groves, Texas (near Beaumont) on Rig 4 of the Meredith Drilling Co. of Houston, Texas—are four 1905 cu. in., 7 x 8¼-in. NKRBU Waukesha gas power units on the platform; and down below a 1197 cu. in., 6¼ x 6½-in. WAKU Waukesha gas power unit. The driller, H. E. Offutt says these Waukeshas have worked constantly for years with no major repairs. It's that way *all over the oil fields*. Reliability is only one big reason why Waukeshas dominate. Diesel, LPG, natural gas, gasoline—to 1235 hp. Get Bulletin 1079.



487

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Design Technique Simplifies Well Evaluation Mathematics

Produced by electronic computers, the Opti-Flow design technique eliminated 8 of the 12 variables from involved mathematics used in well evaluation. This permitted development of a mathematical formula that was programmed through an electronic computer to provide a wide range of master curves covering nearly every well and production situation. These are plotted on charts for rapid problem-solving.

Designed by Garrett Oil Tools of Longview, Texas, the system slashed production costs on wells in the field. It has resulted in savings in compressor horsepower and in overall operating costs in two years of field testing.

Success of gas lifted wells depends upon a fine balance between engineering evaluation of the well and the equipment used.

Garrett has worked with other production engineering groups to find a solution to all gas-lift problems.

They have eliminated as unnecessary all but four unknowns:

1. How deep and at what pressure the gas should be injected for maximum return with minimum compressor horsepower?
2. What effect does existing wellhead back pressure have on design of the well?
3. What minimum tubing size would produce the well at the desired rate?
4. How can you get full operating pressure to the point of injection without excessive loss on deep wells?

Technique determines the correct spacing of valves designed to unload to, and maintain, the most efficient point of injection. A unique pressure-operated valve included in the design remains sensitive to tubing pressure in the open as well as the closed position.

Unloading and operation are thus achieved with no step-down in casing pressure through a response to change in tubing pressure.

Solving these unknowns by the mathematically produced master curves has enabled operators to make the following savings:

On a 10-well lease an operator saved $216,000 on initial compressor horsepower requirements and $70,080 in annual operating costs by using the master curves to evaluate effect of wellhead back pressures. Under similar production circumstances on a 10-well lease, evaluation of proper injection pressure determined through the Opti-Flow technique has saved the operator $103,500 in compressor horsepower and $58,000 in annual operating costs.

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It's New

Drilling – Producing Equipment

Hardfaced Coupling For Sucker Rods

In a hardfaced coupling for sucker rods, consisting of a fused nickel-chromium-boron alloy, the hardfacing is applied to the entire exterior of the coupling, rather than in bands, in order to obtain maximum corrosion protection. National Supply designed the coupling to overcome conditions encountered in some well environments, where exposure of dissimilar metals sets up currents that undercut hardfaced bands.

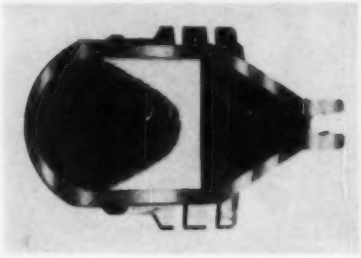
Because this hardfaced coupling has a low coefficient of friction, it is expected to cause less wear on tubing, the manufacturer states.

Hardfacing is approximately .025 in. thick, but it is purposely applied somewhat heavier near the ends than in the middle. Couplings are applied on sucker rods or separately. *The National Supply Company.*

Circle number (1) on reply card.

Concentrated Acid Perforating Charge

Perforating charge that uses concentrated acid as a projectile has been announced by The Western Company.



Stinger perforating charge employs velocity perforating principle to perforate casing, cement and formation, and at the same time places acid in each perforation at the time of perforating.

With acid used as the projectile, charge is designed to provide cleaner perforations and aid effective permeability in formation at time of impact.

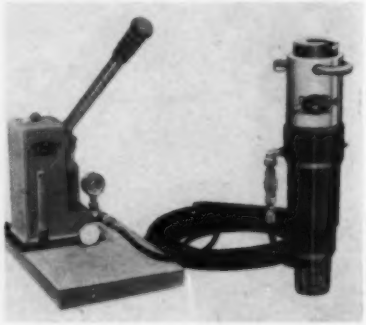
Perforator is run on retrievable steel strip carrier, which gives tool greater versatility than hollow tube carriers. Gun may be run in lengths up to 100 ft, with blanks left in gun for selective perforating. It is rigged either 3 in. OD for 4½ in. casing or 3¾ in. OD for 5½ in. casing. *The Western Company.*

Circle number (2) on reply card.

Hydraulically Operated Wire Line Oil Saver

Hydraulically operated wire line oil saver, Guiberson's Type H, features a large, one-piece rubber packing element of exceptionally long life. Unique design of rubber and bushings forces the rubber to feed inward as well as upward and downward in order to effect a more constant seal.

Unit has a full 2½ in. ram stroke. Spring-loaded ram returns to normal relaxed position when hydraulic pressure is released.



Guide bushings are 2⅜ in. long and are made of non-sparking bearing material. Bushings are split into halves for easy assembly on the line and top and bottom bushings are interchangeable.

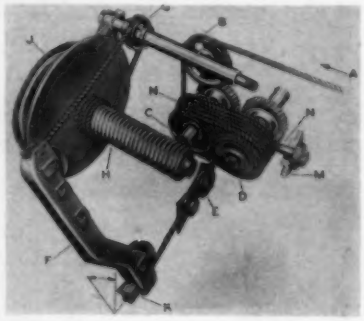
Bushings and rubber are held in the body by a gate which is slotted to receive the line and keyed to the body by a quick-change yoke.

Base is available with 2 in. EUE 8 Rd, 2½ in. EUE 8 Rd, or 3 in. LP 8V field connection. By changing the base, saver may be converted to any 1 of 3 field connections. *Guiberson Corporation.*

Circle number (3) on reply card.

Constant Load Cable Handling System

Hydraulic winch provides cable handling system designed for constant load, speed, torque, and horsepower with one-man operation.



Model CL winch has a 12,000 lb rating and was developed by Braden Winch. Basis for the system is separation of the power and storage functions, which are usually combined in a single drum. Two power drums pull and a large capacity storage drum takes up the cable.

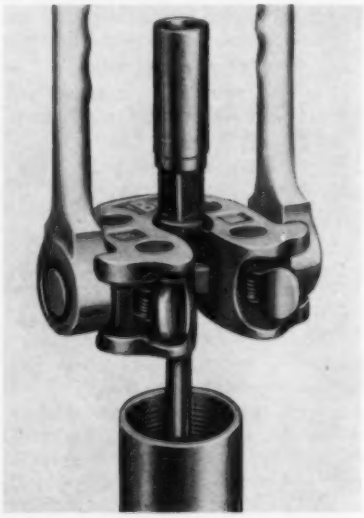
Winch speed and load remain constant because there is no build-up of layers of cable on the power drums, manufacturer states. An improved level winder protects the winch, cable, and load by ensuring that the cable is wound evenly on the storage drum. *Braden Winch Division, Motor Products Corporation.*

Circle number (4) on reply card.

Rod Elevator

Rod elevator designed to prevent bending or kinking of sucker rods even under heaviest loads has been placed on the market by Byron Jackson.

While retaining the arrangement of a reversible U-shaped body pivoted in the elevator bail, new body design employs stops which prevent rotation about the trunnion under load. Entire string is always freely supported in the body seat in line with the lifting load so that there is no possibility of kinking rods even under the heaviest loads.



Bail, which is freely pivoted, swings out of the way or stops upright to receive the hook. The reversible type body has rod seats at the top and bottom, for improved service life. There is no danger of dropping the string, since the front latches must be opened by the operator before the rod can be released.

Elevator is available in a variety of sizes. *Byron Jackson Tools, Inc.*

Circle number (5) on reply card.

Slim Hole Sand Pump

A new slim hole 2 in. OD Sand Pump for 2⅞ in. OD slim hole completions has been introduced by Miller Sand Pump.

Sand pump has identical design to company's larger pumps. It has accurately machined lug-type bottoms. Lengths are 20 to 24 ft. *Miller Sand Pump Company.*

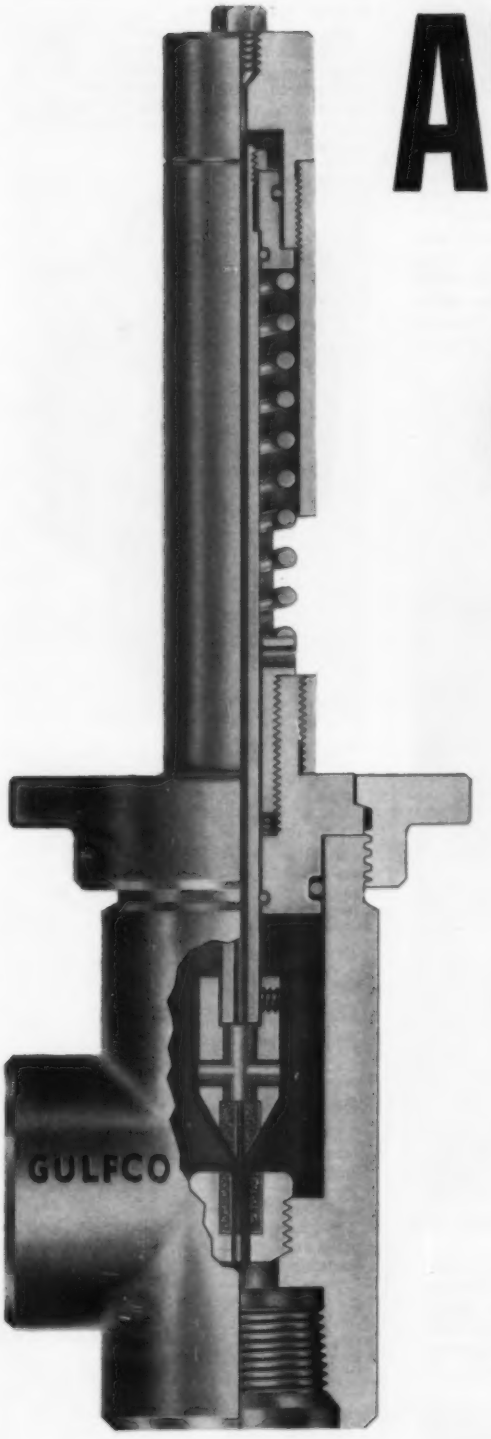
Circle number (6) on reply card.

ANNOUNCING

L.P.C.

GULFCO'S NEW TYPE
AUTOMATIC CHOKE

THE 24 HOUR AUTOMATIC
WELL-FLOW CONTROL



Purposes

1. Eliminates continuous manual changing of chokes on wells.
2. Controls well production without having to shut-in a well.
3. Eliminates swabbing of wells.
4. Lowers gas-oil ratio by maintaining fluid seal on the formation.
5. Prolongs flowing life of wells by conserving bottom hole pressure.

Price $ 195.00

For Complete Details Write For Brochure

GULF COAST MACHINE & SUPPLY CO. GULFCO TRADE MARK PRODUCTS BEAUMONT, TEXAS.

GULFCO

GENERAL OFFICE AND PLANT: 305-315 Orange Street Beaumont, Texas.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Pump-Off Controller

Control device automatically and accurately stops an oil well lift pump whenever a well pumps-off. Eliminates guesswork in estimating well pump-off time.

Designed for application over full range of pump sizes and operating conditions, it measures fluid flow directly. Accuracy remains unaffected by changing well characteristics or other mechanical and environmental conditions.

Unit consists of an electronic controller connected to a sensitive thermistor probe which monitors fluid flow from a well. Probe element is installed in the lead line between the well head and the first check valve. Pulsating flow of fluid, delivered with each stroke of the lift pump, results in electrical signals from the probe.

Upon pump-off, fluid flow diminishes and a corresponding reduction in signal from the probe occurs. Signal reduction causes a relay to operate and stop the pump. *Cutler-Hammer Control.*

Circle number (7) on reply card.

Tungsten Carbide Bits

New style of tungsten carbide rotary drill bits has been introduced for deep hole drilling. They are designed for operation with no blocking of jet streams.

Features include 4 streams jetting over ¾ of the center area of the hole being drilled. Outlets are within 2 in. of the face of the hole, and the streams never jet against the wall of the hole. This prevents drilling over-size hole and caving of the wall of the hole in drilling soft to medium hard drilling.

Bits are designed to prevent blocking by cuttings entering the return annulus. Weight on bit does not retard jet streams cutting into formation, and there is no bottom-hole pressure from bit weight to retard cutting of the formation by the jet stream.

Bit's 4 arms stabilize the bottom end of the string of drill collars and drill pipe, and it helps to keep the bit drilling straight hole. In soft to medium hard drilling, the bit's 4 arms wall-pack the hole.

Illustration shows tungsten carbide bit jet nozzles, 1; cutting blades which are slot seated, 2; gage blades, which are slot-seated to hold bit to gage, 3; and piercing points, 4. Bits range in size from 5⅝ to 6¾ in.

Another bit style, the 4 arm flat face, has beveled cutting edges rather than piercing points.

Bit bodies are one-piece alloy steel. *Phipps Drill Bit Company.*

Circle number (8) on reply card.

Balanced Stem Valve

A balanced stem valve for Christmas tree and general high pressure service has been developed by Grove Valve and Regulator.

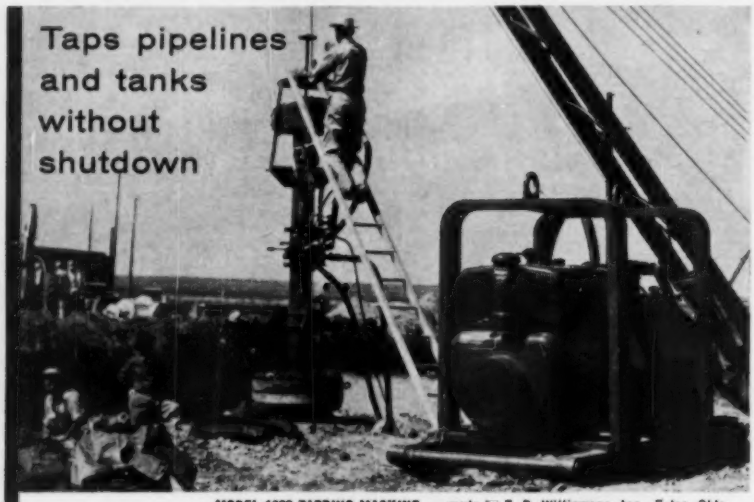
Principal calls for solid stem passing completely through the body, so that the gate may move freely up and down, with no end surfaces for line pressure to push against.

In single stem units, line pressure pushes against the end of the stem, tending to create an additional force which the operator must overcome.

Actually, balanced stem consists of two shafts placed opposite each other and leading in from the top and bottom of the body. They are linked together by the gate. Operating stem pulls against balancing stem to balance the pressure load. Gate-stem unit moves freely up and down like a solid bar, easing operation of valve.

Valves are available in sizes of 1⅝, 1 13/16, and 2 1/16 in. at 10,000 lb W.O.G. with ring joint flanged ends or special end connections. *Grove Valve and Regulator Company.*

Circle number (9) on reply card.



MODEL 1290 TAPPING MACHINE — made by T. D. Williamson, Inc., Tulsa, Okla. — permits making of high-temperature, high-pressure taps into oil, gasoline, gas, steam and water lines without time-consuming shutdowns. It is Wisconsin-powered.

WISCONSIN-POWERED
tapping machine

The Wisconsin-powered unit shown enables you to tap any pipeline or tank without first shutting down transfer operations. And it's as simple as 1, 2, 3. You (1) weld an outlet with valve to the line or tank; (2) mount the machine on the open valve; and (3) tap through. It's safe because the cutter head has spring-loaded steel balls that expand, thus retaining coupon when the tap is finished.

Heart of the equipment is the 20-hp Wisconsin Engine, with hydraulic pump and fluid tank. It is tailored to fit the machine and the job. Heavy-duty precision-fitted construction assures smooth-firing power with minimum wear. And its load-lugging power prevents stalling when the cutting gets tough.

Air-cooling cuts engine size and weight, thus making the machine easier to handle. It also eliminates dry-ups and freeze-ups. The result: trouble-free power in sub-zero cold or 140° F. heat — at lowest upkeep cost.

Contact us if you have a power problem. Write for Bulletin S-249 covering the entire Wisconsin line of engines — 3 to 56 hp.

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Oil Field Distributors for Wisconsin Engines and all types of Utility Units

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Thermoplastic Lost Circulation Plug

Plasti-Plug, a granular lost circulation material made of an engineered blend of thermoplastic and thermosetting plastics, has been introduced to the Cherokee Laboratories line.

Each plastic in the material was individually selected for its special properties. Table of chemical properties shows that overall mixture used has a large variation in physical properties.

Certain plastics used will retain their rigidity and maximum compressive strength over the entire range of temperatures and pressures found in drilling. Others will soften somewhat and under deep hole pressure and temperature will conform to openings between structural members.

This produces a strong, thin, positive seal.

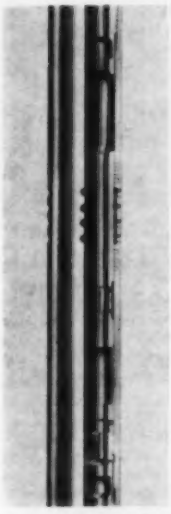
High degree of resilience makes it easy to pump and materials are non-abrasive to pump parts.

Material is produced in medium and fine grade. Fine grade consists of a controlled blend of particle sizes ranging from 20 to 100 mesh. It may be used in any mud system using shale shakers. Medium grade is controlled blend of particle sizes ranging from 8 to 100 mesh. *Cherokee Laboratories, Inc.*

Circle number (10) on reply card.

One-Plane Sealing Circulating Valve

New line of Collet-type circulating valves are wireline operated and allow communication to be established or shut off in a tubing string.



Valves use the internal, sliding sleeve design with the sleeve travelling in a one-piece body. Valve features all sealing on one plane, which is intended to eliminate the possibility of pressure lock or pressure shifting.

As a safety feature, all screwed joints have triple seals with tapered threads that insure positive locking. Valve has O-ring type seals that cannot entrain foreign material, have lip failures or cup reversals, positive sealing under all well conditions, positive sleeve locating, repeatable shifting force which remains constant with all well conditions and no equalizing position.

Garrett circulating valves are available in 1¼, 1½, 2, 2½, 3 and 4 in. sizes and in all popular thread connections. *Garrett Oil Tools.*

Circle number (11) on reply card.

Motor Overload Protector

New kind of overload protection for oil well pumping motors has been announced by General Electric.

Simple, fast-acting Thermo-Tector protection system is available on company's oil well pumping motors from 5 to 75 hp. Two or more miniature heat-sensing switches buried in stator windings provide the protection.

Switches, connected in series with conventional motor control, shut motor off whenever internal winding temperature exceeds a predetermined amount regardless of rate of temperature rise.

System is designed to prevent burnouts from overload heating, and speed of action tends to protect motor even against sudden overloads typical of oil field duty. *General Electric Company.*

Circle number (12) on reply card.

Pipe Straightener

Pipe and kelly straightener may be set vertically on rotary table to straighten either pipe or kelly, or set horizontally for convenient straightening of pipe.

Two quick disconnects permit use of independent hydraulic power source or hand pump.

Hand pump can be swiveled into position for use when straigthener is used either vertically or horizontally. It has two speeds, with slower speed used when straightening load is high. When hand pump is used, quick return of ram is achieved by actuating handle at base of pump.

Supporting rollers may be moved to several positions to provide for various types of bends or kinks, and various sizes of tubular goods. *Joe Stine, Inc.*

Circle number (13) on reply card.

Keep sand content of mud as low as ¼ of 1% with NEW THOMPSON DESANDER

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3. Discharge in desired direction for faster set up
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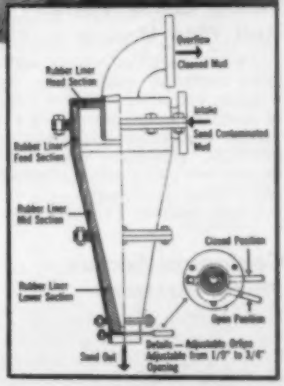

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Iowa Park, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

New Literature

Two-Zone Pump

Supplement sheet describing the new Axelson configuration and design 2-zone pump is available. Design offers several features to operators as it is a shorter, simpler pump with fewer joints. It has longer overlapping fluid ports for flexibility in between zone spacing.

Excepting the cross-over, all parts of the new pump are regular sub-surface pump stock items. *Axelson Division of U. S. Industries, Inc.*

Circle number (14) on reply card.

Insulating Materials

Catalog contains full line of over 30 industrial insulations manufactured by Baldwin-Ehret-Hill. Properties and specifications of complete line of heat and cold insulations for service from sub-zero up to 1900 F are presented.

Spun mineral wool, calcium silicate, and 85 percent magnesia products in block, blanket, felt, fill, cement, and pipe insulation forms are described and illustrated in the 24-page, 2-color booklet. Thermal conductivities and tables of recommended thicknesses are given for each product for appropriate temperature ranges. Illustrated application instructions are also included.

Selection chart, which indicates temperature range of all included types of material, is presented along with illustrations of typical installations. *Baldwin-Ehret-Hill.*

Circle number (15) on reply card.

Market Research

Brochure describes industrial market research performed by Leslie Brooks, who specializes in oil and gas surveys.

Services include product surveys to determine acceptance and standing of products or services, customer reaction to features, and improvements which would make products more acceptable, and design engineering problem surveys for suggested improvements and criticisms. *Leslie Brooks and Associates.*

Circle number (16) on reply card.

Swing Check Valves And Pipe Unions

Twenty-page Catawissa Catalog 60 contains complete engineering data, sizes, weights, and dimensions on complete line of company's pipe unions and swing check valves. It includes information on 2 new products, gasketless cup-orifice unions, ductile iron check valves. *Catawissa Valve and Fittings Company.*

Circle number (17) on reply card.

Geological Society Photo Directory

1960 Photo Directory of the Dallas Geological and Geophysical Societies has been published and is currently being distributed to 750 members of the 2 societies.

In addition to membership photos, directory contains a listing of past and present officers, committees, a cross reference by company affiliation, roster of independents and the constitution and by-laws of each of the societies.

Copies can be obtained by non-members for $2 each from the secretary of the Society. *Dallas Geological and Geophysical Societies.*

Circle number (18) on reply card.

Formation Treating With Implosion Service

Dowell report provides technical information on the Rockshock, implosive formation treating service. Report explains that implosion, the opposite of an explosion, creates a shock wave which generates pressures calculated to be as high as 20,000 psi.

Purposes of process include fracture initiation in hard-to-fracture wells, formation cleaning to improve production, breaking of difficult emulsions, removing of scale deposits, and reduction of breakdown pressures ahead of fracturing and acidizing treatments. *Dowell Division of Dow Chemical Company.*

Circle number (19) on reply card.

Tilting Check Valves

Applications, engineering features, operating principles, dimension and weight reduction of a new line of patented one-piece cast steel tilting disk check valves are discussed in a 12-page, 2-color Catalog No. 14-Y issued by Edward Valves.

One-piece valves are designed for all-welded conventional and nuclear piping systems in 900, 1500, and 2500 lb pressure classes and sizes from 6 to 20 in.

Illustrated publication includes ratings, flow index table, curves, test results, and valve material specifications. *Edward Valves, Inc., subsidiary of Rockwell Manufacturing Company.*

Circle number (20) on reply card.

Swaged Nipples

Brochure includes results of tests by the United States Testing Company on Exner-Dodge Swaged Nipples. Fittings are made from A-106 Grade B pipe and brochure points out that swaged nipples and bull plugs should be as strong as piping installation in which they are installed. *Exner-Dodge, Inc.*

Circle number (21) on reply card.

Bulk Mud Handling

Bulletin offered by Fuller describes use of pneumatic bulk handling methods employed by several service and oil companies. It gives examples of uses in handling mud, cement, and barium sulfate, and the bulletin is illustrated with 5 photographs of typical offshore bulk handling systems. *Fuller Company.*

Circle number (22) on reply card.

Well Servicing Units, Power Pumps for Mud

Bulletins No. WS-1 and P-70 describe Gardner-Denver Well Servicing Equipment and GX Power Pumps for mud service, respectively.

Well service bulletin illustrates equipment and gives specifications of sand-frac, acidizing, sand washing, and cementing units. Power pump bulletin gives sectional view and descriptions, additional features of pumps. Applications for all equipment are shown. *Gardner-Denver.*

Circle number (23) on reply card.

Induction Motor Selection Guide

A 14-page, 2-color illustrated booklet for the selection, application, and as a buying guide for General Electric's Tri-Clad 55 motors is available. It includes all basic information on the motors, single and 3 phase, from ¾ to 150 hp.

Application chart gives types recommended for various loads and ambient conditions. Tables give dimensions, prices, characteristics, and performance data, ordering instructions, modifications, and accessories.

Typical ratings and construction features are pictured in Bulletin No. GEC-1049. *General Electric Company.*

Circle number (24) on reply card.

Chemical Neutralizer To De-Activate Bentonite

A do-it-yourself demonstration kit introducing D.A.B., a de-activate bentonite, is available from Sievers. When added to fresh water the chemical is a neutralizer to make it harmless when exposed to bentonites, bentonitic shales, and bentonitic clays.

Applied in different dilution factors for many uses, it controls bentonite swelling. Oil field uses include well stimulation and well washing, inorganic or organic cleanout jobs, wash to remove swollen clays and release water block, mud-cake removal, and completion fluid with clay base or oil emulsion muds. It is also used with ordinary clay base drilling muds; fracing; as advance waterflooding procedure; and to set cement harder and faster. *Sievers, Inc.*

Circle number (25) on reply card.

Oil Well Meters

Rolo has published Catalog 60-G which contains information on oil well meters, metering separators, well-checkers, metering treaters, automatic custody transfer meters, and calcium chloride gas dehydrators. *Rolo Manufacturing Company.*

Circle number (26) on reply card.

Thermosetting Plastic Mud Additive

Booklet describes Pheno-Seal, a ground and graded thermosetting laminated plastic. Test results by major oil companies are described when material is used in mud to prevent water loss without affecting viscosity or Ph factors, reduce friction and under conditions of extreme well heat. *Montello, Inc.*

Circle number (27) on reply card.

Portable Steel Houses

Four-page Bulletin 60-A covers a representative line of portable steel houses. Included are knock-down types for export, trailer-mounted units, utility houses, and special fabrications up to 52 ft in length. *Joe Stine, Inc.*

Circle number (28) on reply card.

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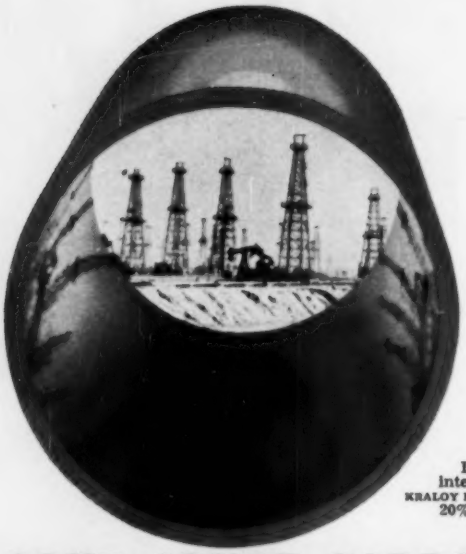

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Immune to electrolytic action and sulfate chemicals, KRALOY defies iron oxide salt deposits, resists scaling and paraffin buildup. Inert, corrosion-proof, it remains impervious to soil and most common acids—*never needs painting or cathodic protection*—cuts repairs and maintenance costs to the absolute minimum. Precision extruded, with mirror-smooth walls for maximum line-flow, KRALOY delivers up to 20% greater volume than same-size pipe of other material. Continuous rigid laboratory control insures unchanging KRALOY quality and long life of service. Available in all sizes from ¼" to 12" with plastic valves and fittings; also as U/L listed* electrical conduit in sizes ½" to 6".

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Electrical Flow Meters

Remote-reading, electrical flow meters for all types of liquids and gases at line pressures to 5000 psi are described in a new bulletin issued by Republic Flow Meters, a subsidiary of Rockwell Manufacturing Company.

Complete line of electrical remote-reading flow meters for steam, water, oil, and special liquids are illustrated. Principles and engineering features are described, including electrical circuits, flow charts, piping and boiler arrangements, and piping requirements for orifices, flow nozzles, and venturi tubes.

Line is described in Publication No. 59-5. *Rockwell Manufacturing Company.*

Circle number (29) on reply card.

Extreme Line Tubing

Spang Extreme Line Tubing is described in Bulletin No. 514, published by National Supply. Plastic-coated tubing for high resistance to corrosion and paraffin adhesion is included for the first time in the new 8-page bulletin.

Illustrations now show the use of a Teflon ring in the box end of joints of this integral-joint tubing. Two more weights of tubing have been added to those tabulated in the bulletin previously published. This makes a total of 9 in 3 sizes which are available in 3 standard grades. *National Supply Company.*

Circle number (30) on reply card.

Buttress Thread Casing Performance Properties

Comprehensive chart available from Youngstown Sheet and Tube shows minimum performance properties of buttress thread casing in an 8-page brochure.

Built for the requirements of deep-well drilling, the casing offers thread design with flank angles of only 3 degrees, and couplings with enough length to engage threads to the last scratch.

Brochure details with illustrations the characteristics of the casing, in sizes 5½ to 9⅝ in. *Youngstown Sheet and Tube Company.*

Circle number (31) on reply card.

Alloy and Sling Chains

A 16-page bulletin on TM Alloy Chain and Sling Chains has been published by S. G. Taylor. Specifications and suggested working load limits are included for single, double, triple, and quad branch alloy slings, miscellaneous slings, and alloy chain attachments. Complete recommendations for the inspection, care and use of TM Alloy Chain are also included. *S. G. Taylor Chain Co., Inc.*

Circle number (32) on reply card.

Instrument Technology

Activities and accomplishment of the Instrument Society of America are covered in the recently published 1959 Annual Report of the Society. Contents include a summary of technical programs and activities; the ISA Journal; translation and publication of Soviet journals; other publications; standards and practices; educational activities; wider society recognition; and a financial report. *Instrument Society of America.*

Circle number (33) on reply card.

Drill String Stabilization

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This is just one of the three *families* of Grant Tools made for reaming, hole enlarging and stabilizing. For full information on these, and a wide range of other down-hole and surface tools made by Grant, send for your copy of the complete Grant Catalog today, or see the Grant section of Composite Catalog!

BECAUSE Grant has *specialized* for over 30 years in down-hole tools for reaming and stabilizing, Grant has perfected not one—but *five* distinct types of stabilizers for every drilling requirement . . . all well conditions . . . and each operator's preference. *Three* types of stabilizing reamers deliver full stabilization for the drill collar string. And for drill pipe stabilization, Grant provides the Cushion Stabilizer and the Drilblade—each for proper stabilization and faster penetration *without increased weight on the bit.*

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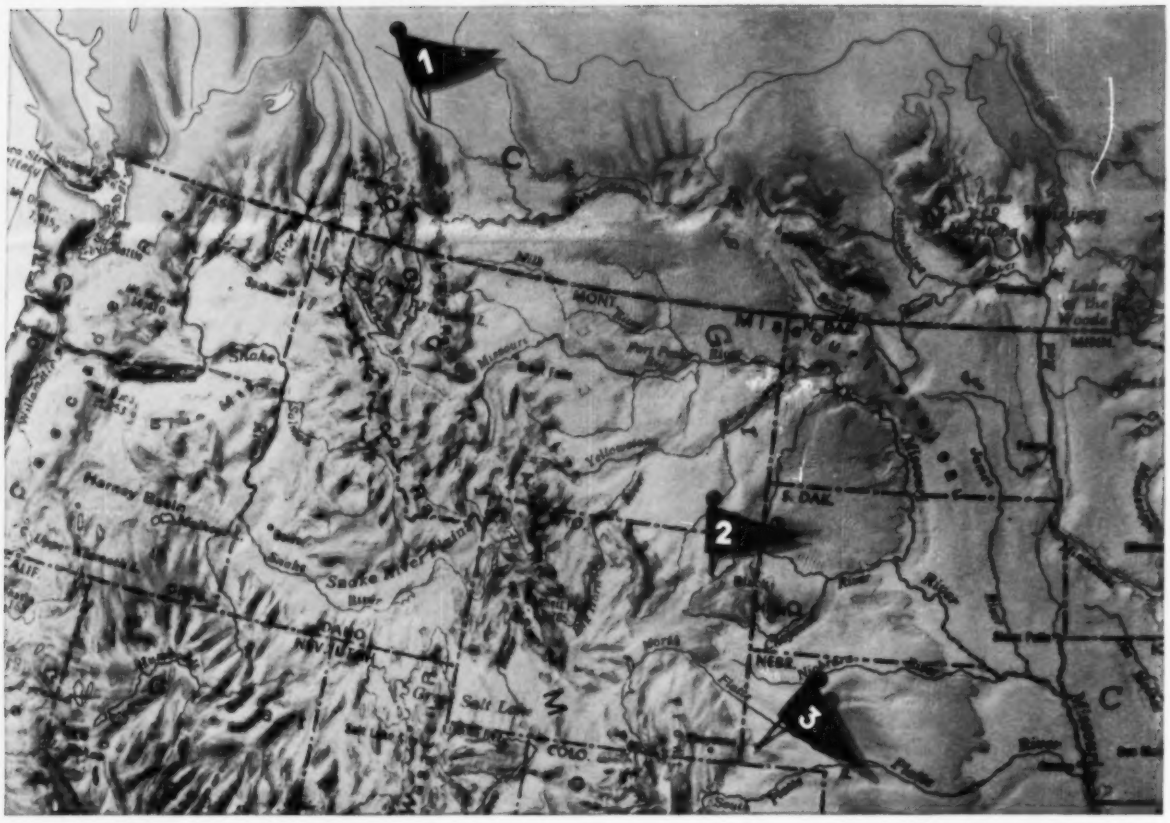

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Hagan Controlled Solubility Phosphates Solved These Scale Problems

Most of the oil field water in the Rocky Mountains is relatively fresh and has a strong tendency to form calcium carbonate scale. Here are three areas where Hagan Controlled Solubility Phosphate solved this problem:

1 *The Pembina Field of Alberta,* where 50°F water from shallow aquifers is pumped into the Cardium sand at 130°F. Stable at lower temperatures, the water deposits calcium carbonate as it warms up near the sand face in the injection well. Scale can build up so fast that injection pressures increase from 300 psi to over 1500 psi in 30 days.

In one section this scale problem was severe. There were forty input wells—each with its own water supply well and high pressure pump. A central treating system was not feasible. But the unique "automatic proportioning" property of Hagan's 15-J Controlled Solubility Phosphate let the operator have the equivalent of forty separate treating plants for less than the cost of a pump.

Bypass feeders were installed at all supply wells and charged with enough 15-J to maintain a continuous 6 ppm feed rate. Once each month, a small booster charge of 15-J was added to keep treatment at an effective level. Injection pressures went back to normal. Total cost for the first year of treatment was less than 2 mills per bbl. of water injected.

2 *In Wyoming's Donkey Creek Field,* a produced water which had only a slight tendency to form scale in the producing wells became a real trouble maker when the water passed through the treaters. Heavy deposits of scale formed on the fire tubes and caused failure—sometimes in less than three months.

Producing wells with a known scaling history were selected for standard downhole treatment with 15-J. Dosage was regulated by monitoring the amount of phosphate in the water at the dump valve of the treater. After six months it was evident that adding a charge of 15-J to the producing wells once each week was enough to prevent scale from forming all the way through the system. A real double benefit treatment—and for a total cost of less than 3 mills per bbl. of water produced.

3 *Kimball, Nebraska.* Here calcium carbonate scale forms in the producing wells so fast that operators in the area have but two choices—preventive treatment—or—go out of business.

Since bottom hole temperatures are extremely high and the upper or "D" sand causes most of the trouble, bypass feeders at the well head are used. A small amount of produced fluid is continuously passed through a bed of 15-J and back down the annulus. Scale is stopped before it starts. One of the early users of 15-J in this area says that since starting treatment two years ago, his workover costs have been reduced 50%.

HAGAN
CHEMICALS & CONTROLS, INC.
HAGAN CENTER, PITTSBURGH 30, PA.

HAGAN DIVISIONS: CALGON COMPANY • HALL LABORATORIES • BRUNER CORP. • BRADFORD LABORATORIES

Treating Facility Uses Advanced Process To Purify Natural Gas Laden With CO_2

First treating facility to use an advanced process which purifies natural gas laden with gross quantities of CO_2 will be installed by El Paso Natural Gas Company. Fluor Corporation Ltd., developer of the process, will engineer and construct the $3,000,000 treating facility. It will produce 100,000,000 standard cu ft of residue gas per day using this new process design. Facility will be erected in Terrell County, West Texas.

Installation will be the heart of an expansion program El Paso is now undertaking in the Brown-Bassett gas field. Natural gas from this field contains up to 53 percent CO_2 which will be removed economically by the process.

Removal process uses an organic solvent to physically absorb high concentrations of CO_2 from natural gas. It can be applied to remove CO_2 from other types of gases, as well.

Solvent's solubility for CO_2 is many times that of water.

Moreover, solvent is characterized by low solubility for hydrocarbons and hydrogen, very low vapor pressure, low viscosity, low hygroscopicity, non-corrosiveness to common metals, and non-reactivity with all components of natural gas.

An important feature, the solvent is commercially available at a reasonable cost.

No heat source will be needed to run the process, since it operates at near ambient temperatures. Furthermore, the plant will require little, if any, auxiliary power because desorbed CO_2 and high-pressure solution will be used to drive the solvent recycle pump turbines.

Solvent process was field-tested in a pilot plant built and operated by El Paso to purify 1,500,000 std cu ft per day of feed gas.

Economics have proved favorable for treating gas laden CO_2 at high pressures.

To date, three patents have been granted covering features of the process.

Unconventional Well Stimulation Technique Uses High-Speed Injection of Slow-Reacting Acid

Unconventional new well stimulation technique has been used in the Permian Basin area of West Texas and New Mexico. Method extends the advantages of acidizing.

Treatment consists of high-speed injection of a special slow-reacting acid. Solution, which does not contain sand, is pumped into the formation at pressures capable of opening natural fissures in the rock, allowing the acid to penetrate appreciable distances from the well bore. Acid attacks exposed rock surfaces, dissolving away the more soluble portions, and leaving the surface rough and furrowed.

When treating pressures are released and the fissure heals, the acid-induced irregularities provide numerous high-conductivity channels for the well fluids to flow through.

Developed by Dowell Division of The Dow Chemical Company, method does not partially block the artificially-formed flow channels it produces, since it does not contain a propping agent. Laboratory tests have shown that crushing or embedment of propping sand often greatly reduces the permeability of a hydraulically-induced fracture. Technique has been applied to more than 30 wells in the Permian Basin. Preparation of well for treatment, and returning it to production afterwards, are considerably less expensive than for fracturing treatments.

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NATURAL GAS ENGINES

American MARC, air-cooled Natural Gas Engines have the same heavy-duty construction as American MARC diesel engines. Consequently, they deliver exceptionally long service with minimum maintenance and attention. For offshore operations or operations without available electric power investigate American MARC Natural Gas or diesel-powered generator sets. Built for positive dependability.

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RUNNING TOUR with MEN in the INDUSTRY

▸ Retirement of **C. T. Hofmeister,** central division manager of purchasing, has been announced by Standard Oil Company of California, Western Operations, Inc.

▸ Several appointments have been made by California Research Corporation. **Dr. B. J. Fontana** has been appointed senior research chemist in the petroleum products research section, Richmond laboratory. **Dr. F. F. Sabins** has been appointed to the position of senior research geologist, sedimentary petrology, in the geology research section of La Habra laboratory. **Dr. J. R. Thomas** has been appointed to the position of research scientist at the Richmond laboratory.

H. F. Beardmore

T. R. Deen

▸ Gulf Oil Corporation personnel assignments in the Houston Production District were announced recently. **H. F. Beardmore** heads the district as manager. Managers of the district's various functions are **T. R. Deen,** exploration; **E. W. Showen,** production, and **M. B. Moseley,** services. In exploration are **J. D. Nunnally,** district exploration geologist; and **R. H. Davis,** district landman. **Don Irwin** manages the Corpus Christi office. Production has **J. A. High,** district production geologist, and **S. H. Miller,** district engineer, and both are based in Houston. Area production managers are **C. J. Rodgers,** Beaumont; **F. J. Mikeska,** Kilgore; **W. H. LeGrand,** Pierce Junction; and **Kinman Thompson,** Victoria.

E. W. Showen

M. B. Moseley

▸ **W. H. Woods** has been elected a vice president of Texas Gas Exploration Corporation.

▸ **John Knudsen, Jr.,** has been elected to the board of directors, and has been appointed to the position of general manager of Kent Petroleum Corporation. **Jess Davy** has been elected to the board of directors. Kent plans to diversify into real estate development while actively continuing gas exploration. Knudsen will advance gas exploration activities, and Davy will handle negotiations for extensive real estate subdivisions.

▸ **Harris Van Zandt** has been elected vice president for exploration and production, the Pure Oil Company. He succeeds **Raymond B. Kelly,** who will continue to serve as a vice president and director.

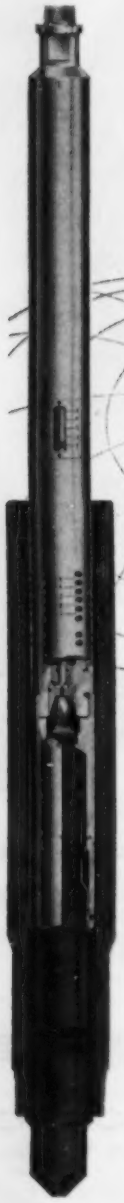
▸ **Ben H. Parker,** president of Frontier Oil Company, Denver, Colorado, was installed as the new president of the American Association of Petroleum Geologists at the joint session of the AAPG and SEPM at the Steel Pier Auditorium.

He succeeds **Lewis A. Weeks,** consulting geologist of Westport, Connecticut, who will continue on the executive committee of the society as past-president for the coming year.

Other new officers of the society for 1960 to 1961 are **Frank B. Conselman,** consulting geologist of Abilene, Texas, the incoming vice president; and **George V. Cohee,** U. S. Geological Survey, Washington, D. C., new secretary-treasurer. **Grover E. Murray,** professor of geology at Louisiana State University, Baton Rouge, was re-elected as editor of the society.

Highest honor of the society, the Sidney Powers Medal, was presented **Henry Van Wagenen Howe,** professor of geology at Louisiana State University. Citation emphasized Dr. Howe's outstanding contributions to paleontologic research and the important role that he has played in educating thousands of young geologists through the years.

The President's Award was presented **Dr. Robert L. Folk,** University of Texas geology professor, for the best paper written by an author under 35 and published in the association's bulletin in 1959. His paper is entitled "Practical Petrographic Classification of Limestones."



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▸ **Robert R. Wallace** has opened a petroleum engineering consulting office in Dallas. His background is in evaluation, reservoir engineering including pressure maintenance and waterflood projects, unitization, and production engineering.

R. R. Wallace

H. E. Haynes

▸ **Harry E. Haynes** has been appointed division geologist in the Dallas headquarters office of **William J. Carey,** independent oil producer.

▸ **John D. Moody** has been employed by Plymouth Oil Company as manager of exploration in its operating headquarters office at Sinton, Texas. Moody will be in charge of the geological, geophysical and land departments. He left the position of exploration coordinator for Gulf Oil Corporation to accept his new position.

▸ **J. S. Detweiler** has been appointed oils planning division manager for the Manufacturing department of Standard Oil Company of California, Western Operations, Inc. He replaces **F. R. Marshall,** who retired after more than 40 years of service.

▸ Personnel assignments in Gulf Oil Corporation's New Orleans Production District have been announced. **Roy A. Payne** is manager. Managers of the district's various functions are: **H. D. Ritter,** exploration; **W. B. Hopkins,** production; and **J. A. Austin,** services. Also in exploration are **E. A. Malone,** district exploration geologist, and **A. J. Carothers,** district landman; and in production, **A. W. Habarta,** district production geologist, and **G. B. Scarborough,** district engineer.

Area production managers are **V. T. Jones, Jr.,** Morgan City, and **H. H. Moore,** Delta. **E. J. Sablatura** is cycling plant superintendent, Krotz Springs.

▸ **Wilfred C. Hugli, Jr.** has been named manager of operations research for Cities Service Oil Company (Pennsylvania). He has been engaged in research activities for 20 years.

▸ **Guy E. Campbell** has been named acting division manager of Sun Oil Company's Mid-Continent Division to succeed the late George W. Chapman. **Jack G. McQueen** has been named acting manager of the division's land department, succeeding Campbell.

▸ **Leo C. Gravis** has been promoted to manager of exploration by Trunkline Gas Company, Houston, in charge of geological, land and geophysical activities.

▸ **Dr. F. C. Goodrich** has been appointed to the position of senior research chemist in the Chemicals Exploratory Research Section, Richmond laboratory of California Research Corporation. **R. J. Mitchell** has been made group supervisor, refinery technical service, at the same laboratory.

Dr. A. W. Trorey has been appointed to the position of senior research physicist, theoretical and experimental geophysics, in the Geophysics Research Section at the La Habra laboratory.

▸ **Ben A. Lovell** has been appointed gas coordinator for Sunray Mid-Continent Oil Company's central division.

▸ **Francis Collins** of The Atlantic Refining Company, and **F. J. McDonal,** Mobil Oil, Inc., both of Dallas, Texas, were recipients of awards for the presentation of technical papers at the 1959 annual meeting of the Society of Exploration Geophysicists, held in Shreveport, Louisiana. The two Dallas men were selected for the awards from 79 speakers who appeared at the annual international meeting in Los Angeles last November.

The slate of candidates for international officers of the Society was announced by **T. O. Hall,** president. **A. E. McKay,** president of Continental Geophysical Company, Fort Worth, and **J. P. Woods,** director of the geophysical laboratory of Atlantic, Dallas, are nominees for president. **John C. Hollister,** head of the department of geophysical engineering at Colorado School of Mines, will oppose **W. B. Lee,** supervisor of geophysical operations for the Houston production division of Gulf Oil Corporation for first vice president.

The candidates for vice president are **Flint Agee,** vice president and manager of North American operations for United Geophysical Corporation, Pasadena, California, and **Robert C. Kendall,** area geophysicist for the Denver area of Shell Oil Company. For secretary-treasurer **George D. Garland,** associate professor of geophysics at the University of Alberta, Edmonton, will run against **Francis A. Hale,** chief geophysicist of The California Standard Company, Calgary, Alberta, Canada.

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EXPLORATION ACTIVITIES

Society of Exploration Geophysicist Nominees Selected, Members Cast Mail Ballots to Elect Officers for 1960

Candidates for international officers of the Society of Exploration Geophysicists have been selected and the 5500 members cast their mail ballots in June. New officers will be elected from eight candidates and the winners will take office next November during the 30th annual international meeting in Galveston, Texas.

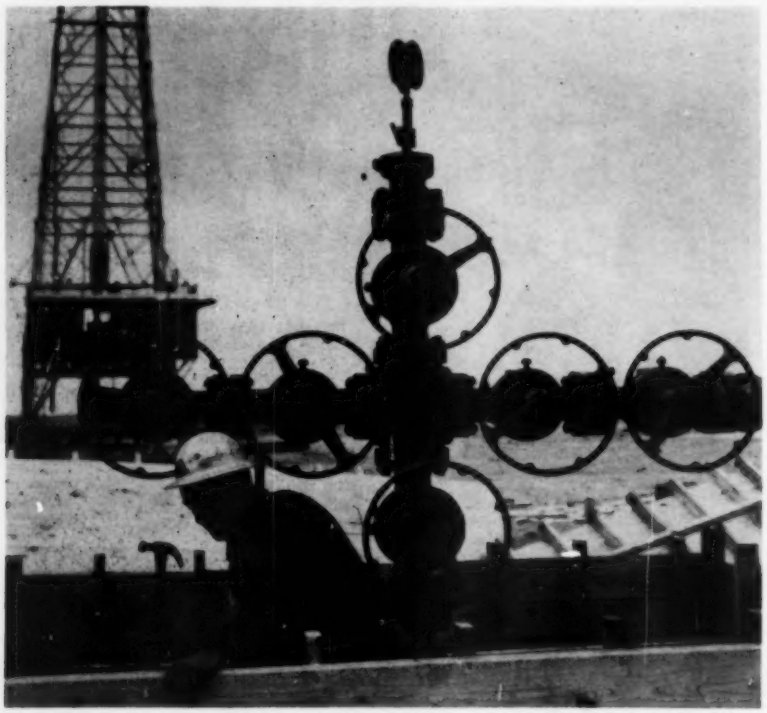
Presidential nominees are A. E. McKay, president of Continental Geophysical Company, Fort Worth, Texas; and J. P. Woods, director of the geophysical laboratory of The Atlantic Refining Company, Dallas, Texas.

John C. Hollister, head of the department of geophysical engineering at Colorado School of Mines, Golden, Colorado, will oppose W. B. Lee, supervisor of geophysical operations for the Houston production division of Gulf Oil Corporation for first vice president.

Candidates for vice president are Flint Agee, vice president and manager of North American operations for United Geophysical Corporation, Pasadena, California, and Robert C. Kendall, area geophysicist for the Denver area of Shell Oil Company.

For secretary-treasurer, George D. Garland, associate professor of geophysics at the University of Alberta, Edmonton, will run against Francis A. Hale, chief geophysicist of The California Standard Company, Calgary, Alberta, Canada.

TEXAS



Mobil puts finishing touches on wellhead of the No. 1 Kathleen Moore, a West Texas wildcat which showed a calculated open flow of over 100,000,000 cu ft of gas and 1500 bbl of condensate per day from a depth of 15,256 ft. Mobil holds some 20,000 acres under lease in the area, and company estimates possibly 6000 acres are on the producing structure. Discovery carried a flowing pressure of more than 10,000 lb per sq in., which probably gives it a higher pressure than any well in West Texas and New Mexico.

TEXAS

First Commercial Field Found In Delta County

Based on two choke gages, a geologically significant new Smackover lime discovery in eastern Delta County, Texas, has been given a preliminary calculated open-flow gas potential of 5,000,000 cu ft per day plus a condensate yield of 7 bbl per million ft. Condensate is dark green in color, of undetermined gravity; and the gas yield is free of hydrogen sulfide.

Discovery gives Delta County its first commercial field, and it brings to 15 the number of Jurassic pay areas established in East Texas. Ten are from the Smackover, third Jurassic member.

This Delta strike is the first from the Jurassic outside the Mexia-Talco fault system, all others being inside or along the fault belt.

Second Exploratory Test Staked Near Bay City

Second exploratory test has been staked 4000 ft west of an apparent gas and distillate discovery five miles south of Bay City. Stekol Panhandle Ltd., Van Dyke & Mejlaender No. 1 Walter W. Fondren, Jr., is projected to 9850 ft to test the Nodosaria Frio sand section.

Operator's first wildcat on the eastern portion of a 24,000 acre block in South Matagorda County, the No. 1 Julia Burkhart, recovered gas condensate in a formation test of the Melbourne sand at 9655 ft. Apparent discovery is now waiting on cement after setting 2⅞ in. production string at 9928 ft.

Nearest previous production is about 1½ miles northeast in the Faith-Mag field.

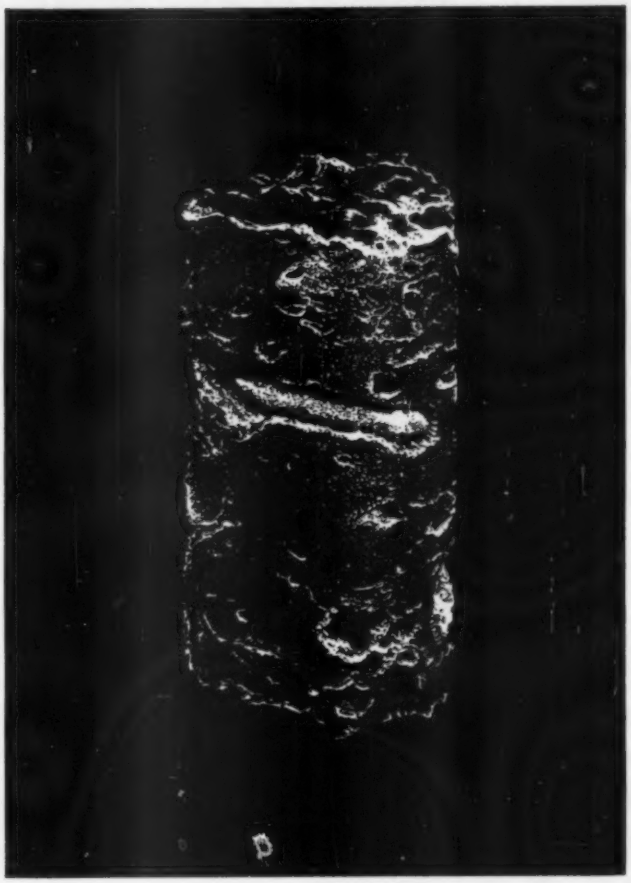
Operator's second wildcat on the block is in the Andrew Smalley Survey, A-90, and spots 660 ft from the north line and 330 ft from the east line of the Fondren lease.

Four Proposed Wildcats Highlight Permian Basin

Applications have been filed to drill wildcats in Pecos, Andrews, Ector, and Borden counties to highlight Permian Basin exploration activity.

Hunt Oil Company has staked the No. 56 Elsinore Royalty Company, six miles southwest of Chancellor on 154,243 acres in the Hunt lease in Pecos County. Proposed depth is 18,000 ft with rotary tool.

Location spots 1980 ft south and from the lines of Section 7, Block A,



Free sets of full-color reproductions of core samples, suitable for office decoration, are available. Request must be made on your company letterhead, and include name of this magazine and date of issue. Address — Core Lab, Box 10241, Dallas 7, Texas.

Underneath Florida

Sunniland Reef, Dade County, Florida: depth, 11,402 feet; thickness, dolomite section, 58 feet (total formation, 255 feet); permeability range, less than 0.1 md. to 2300 md.; porosity, 9.3%; residual oil, 4.0%; total water, 70.2%.

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GC&SF Survey, six miles southwest of the Oats field and eight miles northwest of an 18,673 ft dry hole.

Texaco Inc. will drill the No. 1 DU State of Texas six miles northeast of Andrews in the north central part of Andrews County. Projected depth is 11,200 ft.

Wellsite spots 660 ft from the south line and 2008 ft from the west line of Section 31, Block 4, University Lands Survey, on the southwest edge of the South McFarland field.

Anderson-Prichard Oil Corporation will drill the No. 1-14 Fasken Unit, 14 miles north of Odessa in the northeast part of Ector County. Contract depth is 13,350 ft with rotary tool.

Location is 1980 ft from the north line and 1980 ft from the west line of Section 14, Block 42, T-1-N, T&P Survey, 1¼ miles northwest of Siluro-Devonian production in the South Fasken field.

Dalton H. Cobb will drill the No. 1 A. M. Clayton, eight miles southwest of Gail in the southwest part of Borden County. Scheduled depth is 9900 ft.

Wellsite is 660 ft from the north line and 510 ft from the west line of Section 10, Block 32, T-4-N, T&P Survey, 2½ miles east of the Luckpot field and ½ mile northwest of a 9630 ft dry hole.

Gas Field Discovered in Matagorda County

New field discovery has been made in Matagorda County by M.P.S. Production Company and Houston independent oil operators Van Dyke and Mejlaender.

The companies' No. 1 George Krueger, drilled to 6811 ft, had a calculated open flow potential of 11,500,000 cu ft of gas per day with 1.2 bbl of distillate per million cu ft. Perforations were in the top of the Frio at 6722-26 ft; shut-in tubing pressure was 2450 lb per sq in.

Well is located about six miles north of Bay City on a 367.2 acre lease in A. W. Mangum Survey A-362. It is midway between the North Bay City field and the Armour field. Operators have about 3800 acres in their block.

Operators have asked that the new field be named West Chalmers.

There were several sands in the discovery well which appeared to be commercially productive, the operators reported. Well is a south offset to the companies' No. 1 Pierce Estate, which is still being tested for dual completion.

Dawson County Wildcat Flows Crude on Test

Final completion and state potential of a wildcat discovery in the South Welch area of Dawson County, Texas, resulted in the well flowing 428 bbl in 24 hours of 39.8 gravity oil with no water on a 9/64 in. choke.

The well, No. A-1 E. M. Dupree owned by Husky Oil Company and Tennessee Gas and Oil Company, had a tubing pressure of 775 lb and a gas-oil ratio of 31.5 cu ft to the bbl. Well was completed in the Fusselman formation of Silurian age, in perforations from 11,670 ft to 11,735 ft; and from 11,754 to 11,778 ft.

It is specifically located in the center of the northeast quarter of the northwest quarter of Section 41, Block M, EL and RR Survey.

Husky announced the location for a second well, No. 1 Futrell, located in the center of the southwest quarter of the southwest quarter of Section 40, same survey.

Strawn Sand Wildcat Set in Jack County

A 3600 ft wildcat to test the Strawn sands will be drilled by Trice Production Company in Jack County, Texas.

Operator's No. 1, G. W. Edwards is located 837 ft from the north line and 330 ft from the west line of BBB&C Railroad Survey, A-104. It is about six miles southeast of Antelope.

Trice has a 540 acre block in the area. Nearest production is three and one-half miles west, in the Ada Strawn field.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

LOUISIANA

Wildcatters Discover Two Oil Strikes, Gas Pay

South Louisiana wildcatters have uncovered two new oil strikes and a new gas pay area.

One of the producers was offshore, with the Odeco dual zone discovery in Block 20, South Pelto area. This was an oil and gas find, with 338 bbl a day from one zone, and the other was a gas distillate find.

Pioneer Oil Company has found a new oil pay in Lafourche Parish, in the West Delta Farms area. However, they have elected to case the well off and drill deeper seeking possible other pays in lower horizons.

New gas production was discovered by Forest Oil Company in the Lawtell area. They encountered pressures that were not expected, and sealed off the hole while installing bigger well head equipment.

About an hour and a half flow was obtained on this wildcat, however, and the company is assured of a discovery well.

GEORGIA

Three Bids Received On Atlantic Offshore

Georgia has received three bids for rights to drill for oil and gas in its Atlantic offshore area.

The bidders were Hunt Oil Company of Dallas, Pure Oil Company, and Roderic A. Stamey, a Hinesville, Georgia geologist.

The state Minerals Leasing Commission said Pure and Hunt bid for the entire offshore area with the understanding that after preliminary exploration they would narrow their holding to small portions of the tract.

Stamey bid for a relatively small tract in the vicinity of St. Catherine's Island.

Pure submitted a $50,000 check as its bid for the first year's rental and offered a royalty of one-eighth. Company agreed that after the first 18 months it will reduce its holdings to 75,000 acres in blocks of 10,000 acres each.

Hunt submitted a check for $25,150 as advance rental payment and agreed to drill at least 10 wells to 6000 ft. A one-eighth royalty was offered, and the company will turn back to the state any area in which it does not continue to drill and develop within a five-year period.

CALIFORNIA

Exploratory Well Begun In San Joaquin County

Drilling has begun on the Lake 34-24 exploratory well of Christiana Oil Corporation and Great Basins Petroleum Company in Section 24, Township 2 South, Range 6 in San Joaquin County, California. This well is 1⅞ miles southwest of their last previous exploratory well, No. 1 Antonini.

Hole size on the present well will be 9⅞ in. to 800 ft and 6¼ in. from there to an estimated depth of 6500 ft. Ben Owens Drilling Company is the contractor.

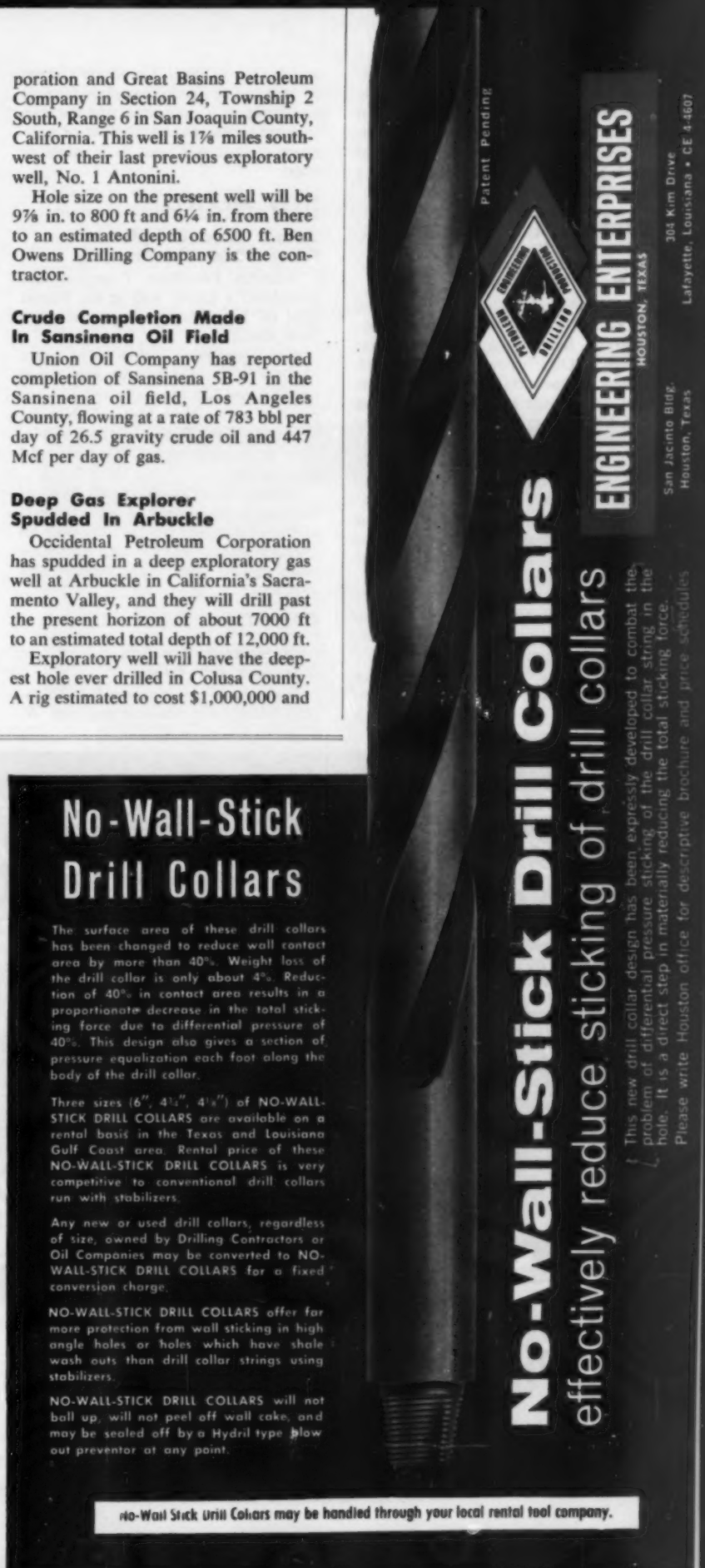
Crude Completion Made In Sansinena Oil Field

Union Oil Company has reported completion of Sansinena 5B-91 in the Sansinena oil field, Los Angeles County, flowing at a rate of 783 bbl per day of 26.5 gravity crude oil and 447 Mcf per day of gas.

Deep Gas Explorer Spudded In Arbuckle

Occidental Petroleum Corporation has spudded in a deep exploratory gas well at Arbuckle in California's Sacramento Valley, and they will drill past the present horizon of about 7000 ft to an estimated total depth of 12,000 ft.

Exploratory well will have the deepest hole ever drilled in Colusa County. A rig estimated to cost $1,000,000 and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designed specifically for deep development has been shipped from Venezuela to drill the well, which is situated in the center of Western Gulf Oil Company's 1920 acre Arbuckle gas field where that company has 12 producing gas wells.

AUSTRALIA

Concession Granted In New South Wales

An additional 3,200,000 acre oil and gas concession in New South Wales, Australia, has been acquired by Texas American Oil Corporation of Midland.

New acquisition would bring the total net acreage acquired in Australia to 6,400,000 acres and an application has been made on an additional 6,400,000 acres in the Northern Territory. All the Australian acreage acquired will be conveyed to Texas Australian Exploration Ltd., a subsidiary of Texas American. The company anticipates offering $1,000,000 worth of public stock in Australia soon.

The parent company plans to transfer an interest in 10 producing wells in West Texas to give the subsidiary overhead expense coverage.

New 3,200,000 acre concession has a large surface structure based on consequent local drainage patterns which are similar to those found on proved oil producing structures elsewhere in the world. It is estimated that the new concession has over 14,000 ft of sediments and a test well is planned in 1960.

NEW MEXICO

Jalmat Field Completion Flows 1200 Bbl Per Day

Westates Petroleum Company has completed a fourth well in the Jalmat field of Lea County in southeastern New Mexico.

New completion is flowing at a rate of 1200 bbl per day through a restricted opening and has been allowed 135 bbl per day under New Mexico's Natural Resources Law. Well is a dual completion in formations of Permian and Silurian age.

Combined allowable production of the four wells completed since the first of the year is 462 bbl per day with an average gravity of 35 deg. Company plans to drill eight more wells in this area.

CANADA

Independent Predicts Gas and Oil Boom

Greatest oil and gas search in Canadian history was forecast by John W. Buckley, president of Canada Southern Petroleum Ltd., as a result of recent oil and gas discoveries in Alberta, British Columbia and the Northwest Territories, and the favorable gas export policy adopted by the Canadian government recently.

He estimated that natural gas sales will increase by 1965 to a level about three times the present volume. He based his opinion on present indications of United States' needs of increased imports and in consideration of Western Canada's preferential position from geographic location and exemption from import restrictions.

Export Permit Spurs Natural Gas Exploration

Crusade Petroleum Corporation has increased their natural gas exploration program due to the recent approval for large scale natural gas export.

Crusade has completed a new farmout agreement with Marpoint Gas and Oil Corporation on Crusade's petroleum and natural gas reservation No. 3710, known as the East Cessford project.

This comprises 14,240 acres immediately east of the Atlee-Buffalo gas field in townships 22, Ranges 6 and 7.

A sub-surface geological evaluation has been made and drilling will start

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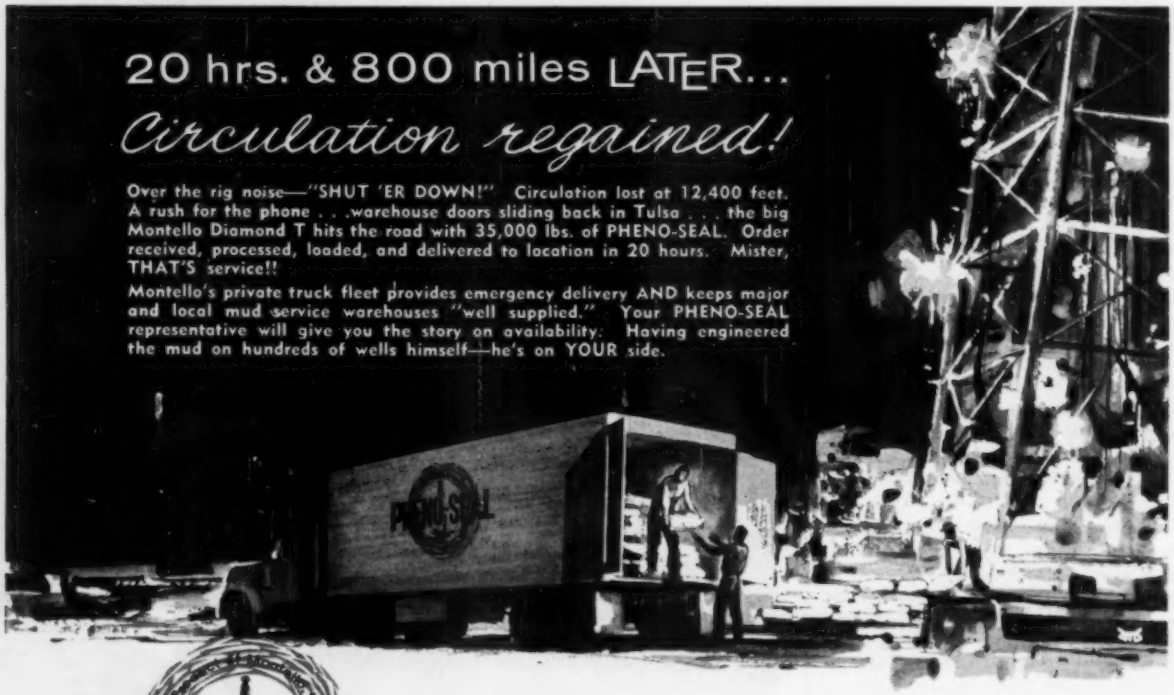

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within 90 days on this property which the company believes to hold strong prospects for the discovery of commercial gas in many zones of the lower Cretaceous formation.

A 20,000 acre petroleum and natural gas reservation, No. 3721, in the Bondiss area between the towns of Lac La Biche and Athabasca has been acquired by Crusade.

Northern Alberta Pipe Lines Ltd., has already applied to the government for a permit to construct a 10¾ in. gas transmission line which will cross the Crusade property and gather and transmit to Edmonton.

Gas Exploration Program Plans Drilling 15 Wells

A gas exploration program calling for the drilling of 15 wells on a 160,000 acre spread in Alberta, Canada has been launched by Zapata Petroleum Company of Midland, Texas.

Large block of leases is in the Southwest part of the province. Zapata, through its wholly-owned subsidiary, Zapata Canadian Petroleum Corporation, secured the acreage in a farmout deal with British-American Oil Company.

The 15 wells are to be drilled during a nine-month period and the 160,000-acre spread is designated the Forrestburg-Donalda block. Two of the explorers scheduled in the program will go to about 6800 ft to test the Blue Hills Lake zone of the Devonian. Other 13 are projected to about 4500 ft to a Paleozoic horizon similar to the Mississippian.

There are already 17 shut-in gas wells either on or offsetting the acreage. These producers create 30 direct or offset locations.

PERSIAN GULF

Second Well Strikes, Produces 6300 Bbl Per Day

Japan's Arabian Oil Company has brought in its second oil well in the Persian Gulf. Company said its No. 2 well struck oil at about 5300 ft and is producing more than 6300 bbl a day.

First well, drilled 27 miles offshore from a floating platform in the Saudi Arabia-Kuwait neutral zone, struck oil January 29; and its production is about 1800 bbl a day.

Company said that the second well is located three miles west of the first producer, and that drilling on a third well will begin immediately.

SPANISH SAHARA

Exploration Planned On Eight Concessions

Plans for immediate exploration work on eight joint venture concessions covering some 5,000,000 acres in the Spanish Sahara were announced by Tidewater Oil Company, acting as operator for itself, and Standard Oil Company of Ohio.

The two companies were granted exploration licenses recently by the Spanish Government. License areas range from the border of Algeria southwestward to the Atlantic Ocean, George F. Getty II, Tidewater president, stated. He also noted that his company and Sohio also have been granted an exploration license for an area near the city of Seville, in southwest Spain.

Phillips Starts Exploring Spanish Territory, Libya

Phillips Petroleum Company has opened subsidiary offices and exploration programs in three new areas.

Phillips Petroleum Company, Libya, is opening an office at Tripoli staffed by J. H. Sneed, resident manager, and J. W. Bruynzeel, Jr., resident geologist.

Another subsidiary, Phillips Oil Company, has opened an office at Madrid, to direct operations in north-central Spain, and an office at Las Palmas, Canary Islands, to direct operations in the Spanish Sahara of northwest Africa.

POWER when you need it!

Year after year . . . Rockford PTO's work smoothly, efficiently, and without maintenance in the Oil Fields. Now they are being specified by more and more oil men as a dependable component of new equipment. Next time, specify a Rockford Power Take Off and rely on the fact, you've selected the best — write for information and specifications.

Available in a wide range of sizes for all popular makes of engines.

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FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

SUPPLIERS' PARADE

Continental-Emsco Company has made several promotions and personnel assignments.

Noble D. Lane, Louisiana has been promoted to division manager in Houston over the South Texas division. W. H. Ramsdell has been made manager of quality control at the Houston plant. Harry Hobbs, Jr., has been made assistant general merchandise manager in Dallas.

Two men promoted to division merchandise manager are Leo R. Walker, who has taken over merchandising duties for the South Louisiana office, and Al L. Beavers, who is now in charge of merchandising for the Houston division.

N. D. Lane

W. H. Ramsdell

Douglas P. Yadon, Jr. is the new division oil country tubular representative for the Tulsa, Oklahoma division, and Dwight G. Barnhart is the new district tubular representative in Columbus, Ohio.

Promoted to pump specialists are Ennis Winford Smith, El Dorado, Arkansas; James E. Yarbrough, Jr., Duncan, Oklahoma; B. R. Grieve, Houston; and Wilfred L. McWhorter, Luling, Texas. Named store managers are Kermit A. Holden, Leeville, Louisiana; and Nealy Nevils, Jr., Lake Charles, Louisiana. T. C. Williams takes over the Lafayette, Louisiana store. William F. Wheeler is the new division production equipment specialist for the Los Angeles, California, division office.

H. Hobbs, Jr.

W. L. Cypher

Baash-Ross Division. F. L. Waller has been transferred to Houston as district sales representative for the Baash-Ross Division of Joy Manufacturing Company. W. Leo Cypher has been named district sales manager in the Rocky Mountain area with headquarters in Denver, Colorado.

Fluid Power Products, Inc. M. H. Bush has been appointed sales manager and a member of the board of directors for Fluid Power Products, Inc. of Long Beach, California, and will handle the domestic and foreign sales of the line of Fluid Power hydraulic pumping units. Bush has been in foreign service for the Standard Oil Company and Texaco Inc.

Midwest Equipment Company, Odessa, Texas, has been appointed distributor for Bucyrus-Erie oil well spudders and well servicing equipment in southeastern New Mexico and southwestern Texas. H. L. DeWees heads the firm, which has branches in Hobbs, New Mexico; and Levelland and Snyder, Texas.

Brown Oil Tools, Inc. recently celebrated the opening of their new Beaumont store, located at 5820 College Avenue Extension, on U. S. Highway 90. With a complete line of service and production equipment, this new location is under the supervision of W. M. Fitzgerald.

W. M. Fitzgerald

W. H. Newman

Wilson Supply Company. W. H. (Bill) Newman has joined the fishing tool division and will operate out of the Houston office as sales supervisor. Until he elected to retire last January, Newman was division drilling superintendent for Magnolia Petroleum Company, with 37 years of service.

MERLA'S SNAP-ACTION

WFM-3

PILOT-OPERATED GAS LIFT VALVE

- Mounts on 2-1/16" OD tubing for duals in 5½" casing
- ¾", 1" and 1¼" concave mandrels available for using the WFM-3 inside 2" and 2½" casing
- Not affected by well temperatures
- Large (7/16") main valve port
- Operating spread controlled by pilot seat size
- May be controlled with surface choke

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manufacturers of oil tools and gas lift equipment

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MERLA TOOL CORPORATION • P. O. BOX 2576
DALLAS 21, TEXAS

The Western Company. New division and district facilities have been established in Farmington, New Mexico, by The Western Company to serve the Four

H. Parsons

W. H. Dennis

Corners area. Harold Parsons is now Rocky Mountain division manager, Farmington. William H. Dennis was named district manager.

Baroid Division National Lead Company. B. R. Fry has been appointed superintendent of the Baroid drilling mud district covering Mississippi, Alabama, North Carolina, South Carolina, Georgia, and Florida with headquarters in Jackson, Mississippi. Rex Haile has been made sales representative in the company's East Louisiana area, with headquarters in the New Orleans office.

The Brewster Company. Two overseas sales and service agencies have been announced by Brewster. Sociedade Importadore de Equipamentos Ltda has been appointed sales representative in Brazil with main offices in Rio de Janiero. Ingeniero Medina Y Cia, SRL, Buenos Aires, has been named sales representative in Argentina.

Oil Well Supply Division. Edward H. Bradley and John W. Coburn have been named district representatives of the Oil Well Supply Division of U. S. Steel at Oklahoma City, Oklahoma. Bobby D. Graham has been named field representative at Bakersfield, California. Leonard W. Burk has been named store manager at Graham, Texas. Thomas A. Hopkins has been named sales representative of the store area at Mirando City, Texas. James E. Goff has been named sales representative for the store area at Harmony, Indiana.

Dowell Division. A. C. Polk has been appointed executive vice president and general manager of the Dowell Division of the Dow Chemical Company. He was formerly Dowell vice president and general manager.

Delta Tank Manufacturing Company, Inc. J. T. Roberts, Jr. has been named eastern region sales manager of Delta Tank's oilfield equipment division.

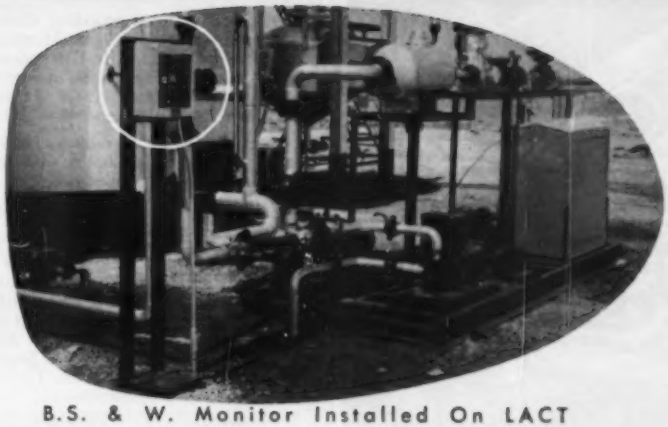
Appointment of George W. Henderson as branch manager of the Houston oilfield equipment division of Delta Tank has been announced. The newly established Houston branch office which he heads is part of Delta's expanding direct sales program.

Flow Equipment Company. C. Gordon Batezell has joined the FLOCO organization as sales office manager.

Southern Engine and Pump Company has opened a branch office at 1323-A North Market Street in Shreveport, Louisiana. The office has been appointed a distributor for ROIline engines and Deutz engines. They will carry a complete line of rotary and centrifugal pumps.

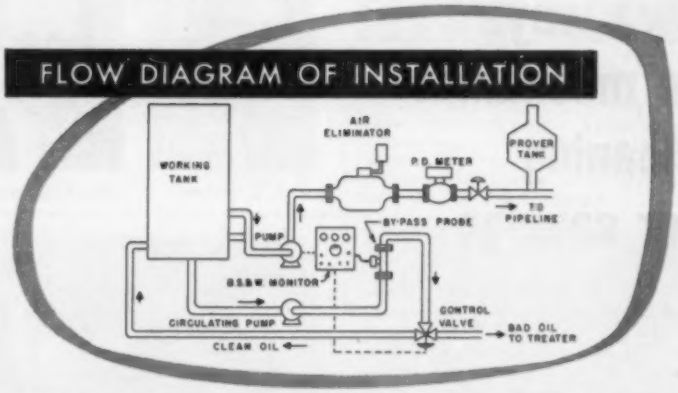
THE MOST IMPORTANT "A" IN LACT

B.S. & W. MONITOR



B.S. & W. Monitor Installed On LACT Pipeline Unit In Osage County, Oklahoma

FLOW DIAGRAM OF INSTALLATION



With the probe installed in-line or in a by-pass, the B.S. & W. Monitor provides continuous inspection and control of b.s. & w. content in crude being delivered to the pipeline. As long as contamination does not exceed setting of Monitor Limit Dial, crude will continue to line. If b.s. & w. content exceeds specifications, Monitor will re-route crude to treater or storage. When crude returns to merchantable condition, Monitor puts it back on line. All this is done AUTOMATICALLY. The B.S. & W. MONITOR MANUFACTURED BY INSTRUMENTS, INC., is the only instrument meeting the specifications for b.s. & w. control as published in the API Bulletin on Automatic Custody Transfer.

SPECIFICATIONS:

Range—From standard 0-3% b.s. & w. to 0-25%
Sensitivity—.05 water contamination
Accuracy—0.1 of 1% water contamination
Power—110 vac, 60 cps
Time Delay—10, 20, 30, 60, 120 or 180 seconds
Probes—2", 3", and 4" flanged, threaded or grooved

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Another benefit of an Oakite ECP*

Two ways to mechanize cleaning for savings

SAVING MANPOWER AND MAN-HOURS for more important work—that's another aim of an Oakite ECP. How's it done? By measuring cleaning equipment precisely to your needs...equipment that can do better cleaning, and more of it, than muscle power alone.

Take the Oakite "Hurriclean" Steam-Detergent Gun. It combines the force and heat of steam with detergent action to make the toughest soils disappear in a flash. It's the lightest (weighs 6¼ lbs.) easiest steam gun to use. And where you don't have steam, an Oakite Sprayer Model 374 (shown above) uses its own compressed air to supply the force.

* *OAKITE ECP is a detailed Engineered Cleaning Program developed to fit your particular operation under the experienced supervision of your local Oakite man. ECP covers all your cleaning needs.*

For details, write Oakite Products, Inc., 47A Rector Street, New York 6, N. Y.

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over 50 years' leadership in industrial cleaning — Est. 1909 — SCIENCE

Dominion Oilfields Supply Company, Ltd. National Supply Company manufactured products will be distributed in Canada by Dominion Oilfields Supply Company, Ltd. of Calgary, Alberta. In addition, certain products of other manufacturers, normally used with National equipment, will be handled.

Mission Manufacturing Company. After being associated with Mission Manufacturing Company for 19 years, Jack Stewart has been appointed domestic sales manager, succeeding T. R. Fullinwider who was recently named vice president.

Reed Roller Bit Company. J. O. Winston, Jr. has been elected to the board of directors of Reed Roller Bit.

Byron Jackson. V. C. Horner has been named operations manager, a newly-established position, of the jet process section. William E. Ridgeway has joined the company as field representative for the near and middle east areas with headquarters at Beirut, Lebanon. Territory includes Aden, Egypt, Eritrea, Ethiopia, Iraq, Iran, Kuwait, Lebanon, Saudi Arabia, the Sudan region, Syria, Turkey, and Yemen.

V. C. Horner

W. E. Ridgeway

Atlas Pipe Inc. W. Tom Pearson has been promoted to general sales manager of Atlas Pipe Inc., division of the Atlas Bradford Company.

W. T. Pearson

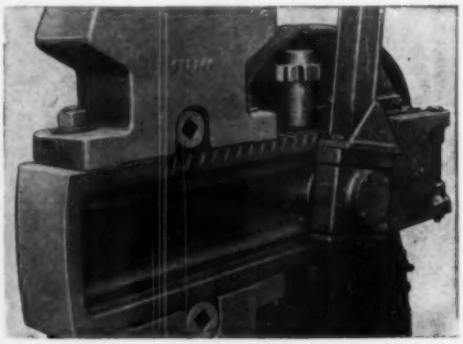
P. Hansen

Wilson Supply Company. Paul Hansen has been appointed regional sales manager for the International Division of Wilson Supply Company. Hansen, with overseas experience in North Africa and South America, will work out of the Houston office.

Pacific Wire Rope Company. A Specialty Products division, with four departments, has been formed by Pacific Wire Rope Company to meet West Coast needs. H. M. Worcester Jr. heads the new division, of which the Rigging department will handle oil drilling needs.

Bevel Associates. Serving as an account executive, Joseph W. Farmer has joined Bevel Associates, public relations and advertising firm of Fort Worth. Farmer has 10 years' experience in journalism, industrial advertising and public relations.

C. Lee Cook Company. Charles E. Williams has been made sales representative in the Tulsa Mid-Continent Division.



This is Jensen's ONE MAN ADJUSTMENT!

The simple rack-and-pinion system on the JENSEN Rotary Balanced JACK can be adjusted by one man — standing on the ground. Provides a smoother stroke throughout the pumping cycle. Assures longer, trouble-free service from sub-surface equipment as well as the pumping unit. Uses less power too! It will pay you to investigate — let us tell you of the benefits obtained by present users!

STOCKED BY YOUR LOCAL SUPPLY STORE

Made by JENSEN BROS. MFG. CO., INC., P. O. Box 477-B, Coffeyville, Kansas

Export Office: 250 Park Avenue, New York 17, N. Y.

JENSEN JACKS

Bowen Itco, Inc. Hilmer A. Olson has been promoted to the position of export sales manager of Bowen Itco, in Houston.

H. A. Olson

H. Bird

Master Tank and Welding Company. Holly Bird has been named sales representative for Master Tanks. He will specialize in sales of storage, transport, local delivery, and domestic tanks, covering the territories of West Texas and New Mexico.

Willis Oil Tool Company. Newly constructed plant and office facilities at 2451 Palm Drive, Long Beach, California, have enabled Willis Oil Tool to speed up production processes and reduce delivery time. The company manufactures flow beans, hi-lo safety shutoff valves, fluid control valves and other hydraulic control devices.

Occupying a two-acre site, the new Willis plant-office complex covers 15,000 sq ft providing room for research, drafting, prototype development, production and greatly expanded test facilities. The plant production area itself covers over 12,000 sq ft and includes more than ample space for engine and turret lathes, milling machines, grinders, drill presses and welding areas.

Panellit, Inc. Joseph E. Klueger has been named sales manager, and George H. Nolte chief engineer of the new southwest region office of Panellit, Inc., Houston, Texas. The company's complete line of process control equipment will be sold and serviced. Other regional offices are in New York City and Wilmington, Delaware.

Hycalog, Inc. A U. S. patent has been granted on a Hycalog design for a diamond drill bit, the V-Door. It was introduced in 1957 and has been used in many oil fields of the United States, Canada, and Latin America.

Tekoil Corporation. Western Well Logging Company of Midland, Texas has been acquired by Tekoil, a Dallas firm. Western is a formation logging company with operations in West Texas, New Mexico, and the Rocky Mountain area.

Well Equipment Manufacturing Corporation. Clark W. Armold has been named sales representative in the Rocky Mountain area for Well Equipment. He will headquarter in Casper.

Liberty Manufacturing Company. First phase of an expansion program has been completed, adding floor space in the plant and office and new manufacturing equipment.

Oil Tool Manufacturing Co., Inc. Gilbert Lodge & Company of Brisbane, Australia, has been made distributor for the Oil Tool Manufacturing Company of both the Williams HoleMaker and K-type slim hole and seismic drilling bits in that continent. Warehouses are located at Melbourne and Adelaide, Australia, in addition to Brisbane.

D. Warren

J. A. Grundy

Reed Roller Bit Company. Dow Warren and J. A. Grundy have been elected directors of Reed Roller Bit Company. Warren is administrative vice president and Grundy is vice president-operations. William E. Scarborough, domestic sales manager, was made vice president-sales.

W. E. Scarborough

W. L. Porter

Welex, Inc. Weldon L. Porter, former Dallas city salesman for Welex, Inc., has been named to fill a newly created post. Porter was promoted to chief completion services engineer, with offices at the company's Fort Worth headquarters.

TWO HEADS ARE BETTER THAN ONE . . .

Except when it is a Hercules Type SOS Stripper Tubing Head.

This head is engineered to fulfill every field requirement for a medium pressure stripper tubing head. Its simplicity of design and ease of operation are outstanding features, and it consistently performs above recommended pressures, when needed.

But this head leads a double life. Remove the cap and the lower body section and put them together. You then have an SO Type Tubing Head that is compact and ideal for pumping a previously flowing well. **This is just one of many Hercules features that continuously give you more for your money.**

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HERCULES TOOL COMPANY
MANUFACTURERS OF OILFIELD EQUIPMENT
GENERAL OFFICES AND PLANT • TULSA, OKLAHOMA
Export Representative Oil Field Equipment Co., Inc. 90 West Street, New York, N. Y.

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NOW . . . A Complete line of

BrakeSol

OIL FIELD CHEMICALS

Developed exclusively for solving particular problems in the petroleum industry.

P.T.C. . . . The original Paraffin Treating Chemical. Holds paraffin in suspension from formation to refinery.

DEMULSIFIER D-7 . . . Universal Treating Compound. Gives cleaner oil with less heat resulting in a BETTER PRICE.

STIM FORM® . . . Clean Well Bore! Designed to remove restrictions in perforations . . . face of pay . . . formations.

CORROSION INHIBITOR CI-123 . . . Designed especially for control of oil field corrosion problems.

GYP and SCALE TREATMENT GS-20 . . . Effective on these types of carbonates and sulphates: calcium, strontium, barium and magnesium.

FOR INFORMATION . . . Contact Supply Store Brakesol Treating Engineer or write direct!

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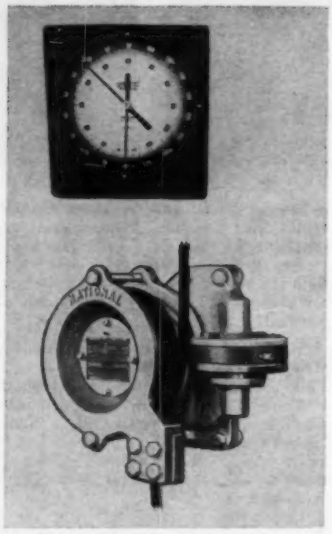
SMALL RIG INDICATOR

NEW • NEW • NEW • NEW • NEW

MARTIN-DECKER TYPE "G"

for the Small Drilling Rig Workover or Production Hoist

The new Type "G" Weight Indicator, is a scaled down model of the Martin-Decker Type "D", "E" and "FS" Weight Indicators. It includes the SENSATER permanently mounted in the Deadline Anchor and all other advantages of the larger units, yet it is light and small enough for the stringent requirements of portable rigs.



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3431 CHERRY AVENUE, LONG BEACH 7, CALIF.

WORLD'S PRINCIPAL MANUFACTURER OF OIL WELL DRILLING INSTRUMENTATION

When It Comes To . . .

REELS

Drillers and Producers Choose . . .

Mathey

Many Combinations of Sizes, Drives and Power

Call or Write for Further Information

Mathey Measuring Line Reels for bottom hole pressures, temperature surveys, deviation tests, calipering, paraffin cutting, sampling and many other wire line jobs. Mathey Reels are designed to meet your requirements of line speed, line pull, spool capacity and type of power. Special reels are engineered and manufactured to your specifications.

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Live the Life of Riley at the
BAKER HOTEL
MINERAL WELLS

Restful — Relaxing — Recreation — Wonderful Food — Various "Brazos Club" Memberships Available. Healthful Stimulating Baths . . . Economical Five Day Package Plan.

Make Your Reservation NOW
BAKER HOTEL
MINERAL WELLS

FAirfax 5-3331

Halliburton Oil Well Cementing Company has announced the appointment of Harold Grant as regional training supervisor for the southern region—its Corpus Christi, Houston, New Orleans and Shreveport divisions. Grant, formerly district superintendent for Houston field locations, replaced D. J. Sargent, now assistant division manager for the company's New Orleans division.

H. Grant

D. Kyle

W. C. Norris, a division of Dover Corporation with plants and general offices in Tulsa, Oklahoma, has increased its sales staff by appointing Don Kyle as sales representative. Kyle, formerly with Oil Well Supply, was assigned to the company's West Texas sales division with headquarters in Hobbs, New Mexico.

Skinner Brothers Company. Earl McGill has been named assistant to the director of sales for Skinner Brothers Company, Dallas-Tulsa oilfield equipment manufacturer. McGill's promotion to the newly-created position followed five years of service as field representative in the Permian & Delaware Basin area.

Oil Center Tool Company of Houston, Texas, has acquired a substantial interest in Luceat, S. A. of Sens, France, as part of the firm's program for increased participation in international trade. Luceat, S. A. manufactures components for the petroleum industry and will manufacture O-C-T wellhead equipment.

Bowen Itco, Inc., Houston, Texas, has announced publication of two catalogs, one listing the complete range of specialty tools for wireline service, and the other a variety of equipment under the name of Bowen-Kinzbach. Bowen Itco recently purchased the Kinzbach Tool Company.

Keenan Pipe & Supply Co. Roy W. Johnson, formerly executive vice president of Republic Supply Company of California, has been appointed manager of contract sales for Keenan Pipe & Supply Co. Johnson's headquarters will be in Los Angeles.

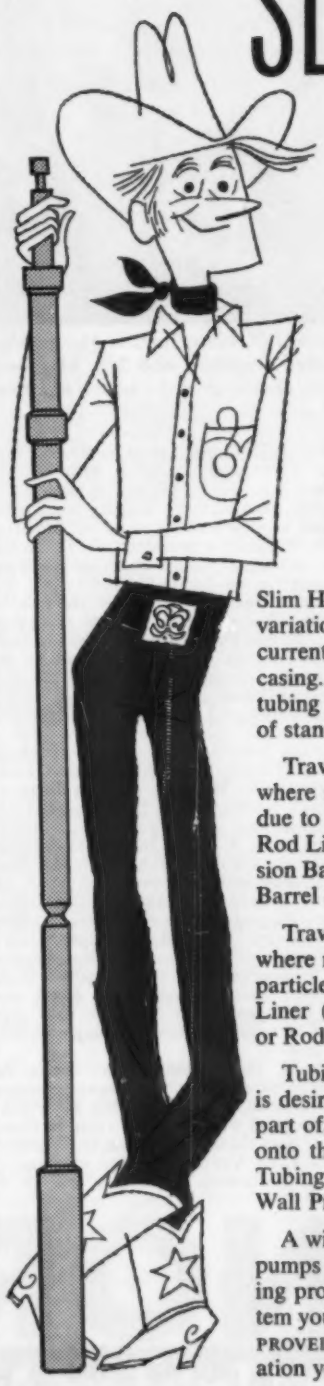
Macco Oil Tool Company, Inc. R. Z. (Bob) Mendenhall recently rejoined the Sales Department of Macco Oil Tool Company, acting as liaison between the Houston office and distributors throughout the world.

American Potash and Chemical Corporation has transferred Robert E. Zator from its Whittier, California, laboratory to the firm's Los Angeles office. Zator joins the company's market research group as an analyst.

Avondale Marine Ways, Inc. Ed Neely has been appointed sales engineer for the oil tools department of Avondale Marine Ways, Inc. The company specializes in the repair of oil drilling equipment.

Longhorn Supply Company. The appointment of W. F. Morris as vice president and Vesper Armstrong Jr. as secretary-treasurer of Longhorn Supply Company has been announced. Mrs. Geraldine F. Irwin was promoted to assistant to Armstrong. Company headquarters are in Houston, Texas.

SLIM HOLE PUMPS



"Well-proved"

Slim Hole Completions are essentially scaled down variations of conventionally sized well bores. A current trend being the use of 2⅞" O. D. tubing as casing. A pump for these completions where small tubing is used is necessarily a scaled down version of standard A.P.I. type pumps.

Traveling Barrel Rod Pumps for installations where sand or solid particles cause pump to drag due to wedging. These pumps can be furnished as Rod Liner Traveling Barrel (R. L. T.), Rod Precision Barrel (R.W.T.) or Rod Heavy Wall Precision Barrel (R.H.T.).

Traveling Plunger Rod Pumps for installations where no difficulty is encountered by sand or solid particle. These pumps can be furnished as Rod Liner (R.L.B.), Rod Precision Barrel (R.W.B.) or Rod Heavy Wall Precision Barrel (R.H.B.).

Tubing pumps are used where maximum volume is desired. The barrel screws onto, and becomes a part of, the tubing string while the plunger screws onto the rods. These pumps can be furnished as Tubing Liner Pumps (T.L.E.) or Tubing Heavy Wall Precision Barrels (T.H.E.).

A wide variety of materials is available for these pumps to provide combinations to meet all producing problems. Regardless of the rod pumping system you should choose, installations of these WELL PROVED PUMPS will give you the trouble-free operation you desire.

WRITE FOR BULLETIN 206

DW-20

PACIFIC

DRESSER INDUSTRIES INC.

OIL • GAS • CHEMICAL ELECTRONIC • INDUSTRIAL

PACIFIC PUMPS

Inc... A Division of Dresser Industries, Inc.

HUNTINGTON PARK, CALIFORNIA

Mid-Continent:
1358 So. Sheridan Ave., Tulsa 12, Oklahoma
Pacific Pumps of Canada, Ltd.,
Edmonton, Alberta

Engineered Oil Tools, Inc. Regional warehouse and service points have been established by Engineered Oil Tools, Inc. at Odessa, Texas and Oklahoma City. W. B. Jennings is in charge of operations at Odessa, with E. G. Williams in charge at Oklahoma City.

Merchants National Bank of Mobile. Petroleum Engineer Peter C. Petroutson has been elected assistant vice president of the Merchants National Bank of Mobile, Alabama. Previously he was in the bank's oil department.

Larkin Packer Company. B. J. Jostrand, until recently secretary and treasurer of Larkin Packer Company, a division of Koehring Company, is now vice president of Larkin Packer. The company manufactures oil field specialties, and is located in Waxahachie, Texas.

Frank T. Quinn, left, is the newly-elected president, and John M. Proos, right, chairman of the board of Layne & Bowler, Inc.

Star Perforators, Inc. A new company, Star Perforators, Inc. of Fort Worth, Texas, has been organized to offer perforating, radioactivity logging and associated wireline services to the oil industry. J. B. Vaughan is president; W. D. Smith, vice president. Initial operations will be centered in southwest Texas.

Welex, Inc. Among recent changes by Welex, Inc., wireline service company, was the combining of the Louisiana Gulf Coast Division and Texas Gulf Coast Division into a single Gulf Coast Division under division manager W. L. Laflin, who transferred from New Orleans to Houston.

Other promotions and transfers within the Gulf Coast Division included: Gilbert Hester from Houston sales engineer to district manager; G. E. Johnson from Alice shooter to Corpus Christi district manager; J. R. Evans from sales engineer to district manager at Alice; W. R. Marshall from sales engineer to division operations manager at Houston; C. E. Eicke from logging operator to sales engineer at Houston; R. K. Riggle from Mission field engineer to Beaumont sales engineer; C. F. London from field engineer to assistant district manager at Alice; and W. R. Riggan from Lafayette field engineer to assistant district manager at Victoria.

R. H. Huddleston, former senior development engineer, was named manager of research and engineering at Welex's Research & Engineering Center in Houston. Other changes included: G. T. O'Bannion from Ventura division engineer to R & E training instructor, and D. L. Divine from Beaumont trainee to R & E engineer.

In the Oklahoma Division, changes included: R. R. Lovely from logging operator to field engineer at Liberal; J. W. Webb from shooter to sales engineer at Pauls Valley; W. M. Clover from Oklahoma City field engineer to Pauls Valley sales engineer; division sales manager R. B. Burns from Tulsa to Oklahoma City; and M. F. Rockwell from Bristow shooter to Shawnee sales engineer.

J. W. Pickering was transferred from Hays district manager to Tyler district manager, and C. D. Hendricks, Farmington rigman, was made Kimball sales engineer.

Announcing
the new
MILLER
"SLIM HOLE"
SAND PUMP

Miller 2" OD Sand Pumps for 2⅞" OD "Slim Hole" completions are now available. The 2" OD Sand Pump, with accurately machined lug-type bottoms, is designed exactly the same as larger Miller Sand Pumps.

SAND PUMP SIZES
O.D. — 2, 2½, 3, 3½, 4¼, 5, 5½, 7 in.
Lengths 20, 25, 30 ft. for 3" OD and larger pumps. 20 and 25 ft. for 2½" pump. 20 to 24 ft. for 2" pump.
Composite Catalog, Page 3688
Write for descriptive price list

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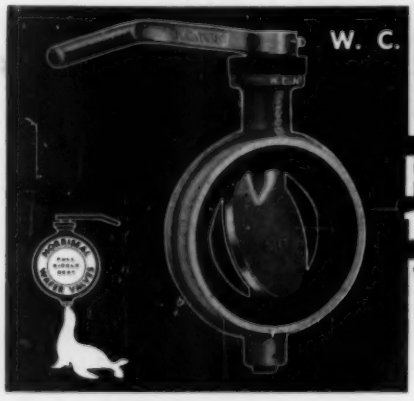

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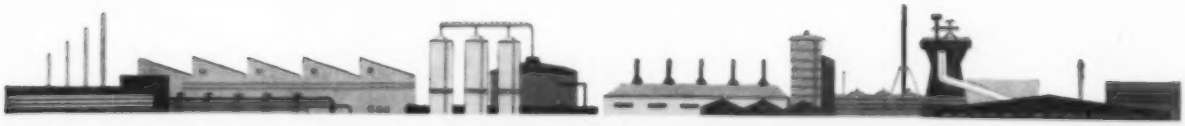

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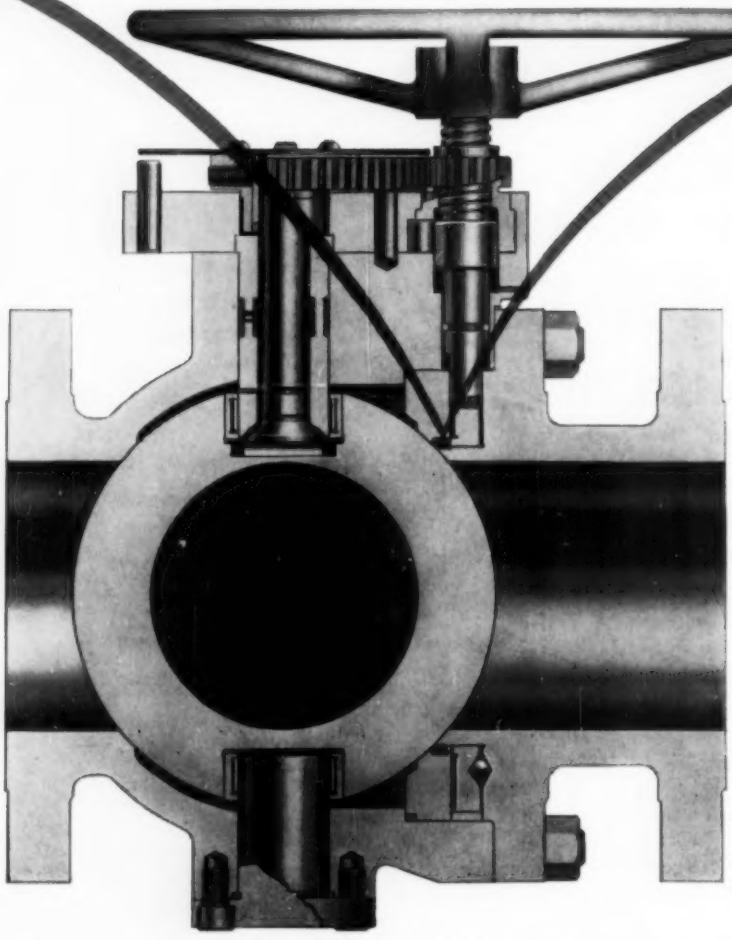

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CONSTRUCTION BRIEFS . . . news of plants to come

▸ **Humble Oil & Refining Co.'s** 40,000,000-lb per year polypropylene plant, now onstream at Baytown, Texas, marks Humble's entry into the plastics business. The polyolefin unit, largest of its type in the world, represents an investment of more than $30,000,000, including research and development. Photo shows part of pneumatic conveyor system which moves the plastic pellets of polyproplyene from funnel-shaped storage bins to packaging rooms.

▸ **World's largest crude running unit** (150,000 bbl per day) and a new catalytic cracking unit with a fresh feed rate of approximately 47,600 bbl a day will be constructed at the Texas City plant of American Oil Co., subsidiary of Standard Oil Co. (Indiana), by M. W. Kellogg Co. Completion is expected by fall of 1961. Amoco is still taking bids on a 14,500 bbl a day alkylation unit, which also will be the largest such unit in existence.

▸ **Tennessee Oil Refining Co.,** division of Tennessee Gas Transmission Co., has awarded contract to O. L. Olsen Co. for construction of a natural gas processing plant near Palacios, Texas. Designed to process 55 M Mcf of natural gas per day, the plant will extract a mixed stream of propane, normal butane, iso-butane, and natural gasoline. Daily production will be an estimated 58,000 gal.

▸ **Cities Service Refining Corp.** will build a multi-million dollar petrochemical plant at Lake Charles, Louisiana, to produce 120,000,000 lb of orthoxylene annually.

▸ **Delhi-Taylor Oil Corp.** this month will complete a new unit to produce about 70,000,000 lb a year of high purity orthoxylene at its Corpus Christi, Texas, plant.

▸ **World's second Hydrar unit,** to produce 20,000,000 gal of cyclohexane annually, is being built at Continental Oil Co.'s Ponca City, Oklahoma, plant by Procon, Inc., Des Plaines, Illinois.

▸ **Modernization and modification** of Warren Petroleum Corp.'s plants at Monument, New Mexico; McLean, Texas, and Fostoria, Texas, will increase total production of light hydrocarbons approximately 70,000 gal daily.

▸ **Plants at Odessa, Texas,** for production of olefins, polyolefins, and chemicals will be built in a joint venture by El Paso Natural Gas Co. and Rexall Drug & Chemical Co. First plants to be built are to begin production in early 1962 and will produce ethylene, propylene, conventional polyethylene, linear polyethylene, and polypropylene. Initial capacity of the olefin plants will be over 200,000,000 lb per year, and combined capacities of the polyolefin plants will be in excess of 150,000,000 lb annually. Cost is estimated at about $75,000,000, to be spent over a 4-year period.

▸ **Ashland Oil & Refining** will build its synthetic benzene and naphthalene plant next to its Catlettsburgh, Kentucky, refinery instead of at the Tonawanda, New York refinery of its subsidiary, Frontier Oil, as originally planned. The unit, to cost $5,000,000, will have capacity of 75,000,000 lb of naphthalene and 15,000,000 lb of benzene annually.

▸ **Mobil Oil Company** will build a delayed coking unit at its Beaumont, Texas, refinery to convert 20,000 bbl per day of heavy oil into higher value products such as gasoline, light fuel oil, and petroleum gases. Unit will be completed in spring of 1961.

▸ **A $15,000,000 plant** to produce anhydrous ammonia, urea, and related products will be built near Joplin, Mo. by Solar Nitrogen Chemicals, Inc. owned equally by Standard Oil Co. (Ohio) and Atlas Powder Co.

▸ **Largest propane deasphalter** in the United States, a $3,600,000 unit designed for 10,500 bbl per day charge, will be built at Sun Oil Co.'s Toledo, Ohio, refinery with completion expected in spring of 1961. Foster Wheeler Corp. has the engineering and construction contract.

▸ **The Indian Government** will build a 500,000 to 1,000,000-ton refinery at Cambay, Bombay State. A 150,000 tons per year refinery at Gauhati will be completed by December 1961, and a second refinery at Barauni, with annual capacity of 2,000,000 tons, may be completed by 1963.

▸ **A $10,000,000 chemical fertilizer plant,** the first in Central America, will be built near the Pacific port of Acajutla, El Salvador by Fertilizantes de Centro America.

▸ **ENI's 160,000,000 lire petrochemical plant** now under construction at Gela, Sicily, will refine oil and produce petrochemicals and thermoelectric power. Plant will begin operating in two years.

▸ **World's largest sulfur plant,** a 1000-ton recovery unit, is now onstream at the Lacq, France, gas processing plant of SNPA (Societe Nationale des Petroles d'Aquitaine). Design, engineering, procurement, and construction supervision were performed by Ralph M. Parsons Co., Los Angeles, in collaboration with S. A. Heurtey Co., Paris. New unit will be joined by its twin in a few months, bringing total processing capacity of the plant to 750 M Mcf of raw gas a day and sulfur recovery to 4000 long tons per day.

THE NEWEST AND MOST ECONOMICAL PHOSPHORUS ADDITIVE!

"Ethyl" Ignition Control Compound 4 provides more phosphorus per pound at a lower cost

A NEW ECONOMICAL PROCESS for manufacturing ICC 4 (trimethyl phosphate) now provides refiners with the lowest cost phosphorus protection. Thoroughly tested in both laboratory and field, it proved its effectiveness as a gasoline additive and had no undesirable side effects.

A new plant for manufacturing ICC 4 has been completed at Baton Rouge, La., and commercial quantities are immediately available. This phosphorus compound is an exclusive Ethyl product and its use as a gasoline additive in the United States is covered by patents.

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Effectiveness of "Ethyl" ICC 4

Ethyl Research tested the effectiveness of ICC 4, in gasolines containing 3.0 ml. of tetraethyllead per gallon, as a suppressant of surface ignition and rumble, and as an extender of spark plug life. In every case, ICC 4 proved to be equally effective with other phosphorus compounds on the market, and showed a marked improvement in cost effectiveness.

Surface ignition tests were made in single-cylinder engines.

Phosphorus	Relative surface ignition counts, %
None	100
0.2 theory ICC 4	26
0.3 theory ICC 4	20

Rumble frequency was tested in a V-8 engine with a 12 to 1 compression ratio.

Phosphorus	Rumble, % of observations	Mileage Accumulations
None	100	8,000
0.4 theory of ICC 4	25	9,500

Spark plug life was tested in V-8 engines operated on a dynamometer.

Phosphorus	Relative life to fouling, % Engine A	Engine B
None	100 (27 hours)	100 (32 hours)
0.2 theory of ICC 4	330 (89 hours)	355 (114 hours)

No Deleterious Side Effects

Exhaustive tests in current fuels show that ICC 4 has no undesirable effects on gasolines or engines:

1. Low antiknock destruction.
2. No effect on intake system deposits.
3. Satisfactory exhaust valve durability.
4. No effect on pistons, rings, or bearings.
5. No effect on storage stability of leaded gasolines.
6. And ICC 4 is compatible with other gasoline additives.

Solubility a Minor Factor

Because ICC 4 is water soluble, some phosphorus is extracted from gasoline into water contained in storage and pipeline systems, of course. However, losses are small and economies are only slightly affected.

Extractability studies indicate that initial losses will be small in routine blending or storage operations. Moreover, the concentration in water bottoms will slowly reach equilibrium with the concentration in gasoline: thereafter losses will be negligible. Losses are greatest when ICC 4 is first introduced.

Economics of "Ethyl" ICC 4

Ethyl has studied typical refining situations to establish the savings that can be made using ICC 4 as a substitute for phosphorus compounds that are less water soluble. Evaluations carefully allowed for losses in blending, storage and service station tanks.

First year savings range from 10 to 15% of total phosphorus additive cost. Greater savings are made when water bottoms achieve equilibrium or are eliminated.

How Ethyl Research can help you

Like all "Ethyl" products, ICC 4 is backed by a full complement of technical and research services. If you wish, your Ethyl Representative will arrange for technical specialists to assist you in determining its most economic use in your refining situation. He also will be glad to supply you with detailed technical literature.

Samples are available now for test purposes from your Ethyl Representative, or by writing to Ethyl Corporation Research Laboratories, Technical Service Department, 1600 West Eight Mile Road, Ferndale 20, Michigan.

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For Petrochemicals and Petroleum Processing

Brazil . . . land of opportunity

BRAZIL BECKONS as a vast frontier to the petrochemical and petroleum processing industries. While these industries are in their infancy in Latin America's principal industrial nation, economic indicators point to dramatic future growth comparable in many ways to that in the United States in the past 15 or 20 years.

So new is the petroleum industry to Brazil there was no crude production of consequence prior to creation of Petroleo Brasileiro S.A. (Petrobras), the government monopoly oil company, in 1953. Crude production has increased from 2719 bbl per calendar day in 1954 to approximately 70,000 in 1959, and this figure is expected to jump to 130,000 in 1960 (see Table 1). The outlook is favorable for continued success in locating oil so that Brazil soon will become self-sufficient in oil production even though the consumption rate is increasing rapidly.

Refineries equipped with catalytic crackers and catalytic reforming units are being built at strategic locations in relation to oil fields and utilization of products made by each refinery. Brazil already has plants producing ammonia, polystyrene, polyethylene, and asphalt, and a 40,000 tons per year GR-S synthetic rubber plant is under construction. Names of refineries, approximate capacities, products produced, and status as to whether they fall under

TABLE 1. Brazil's Crude Production.

Year	Bbl Per Calendar Day
1954	2,719*
1955	5,540
1956	11,089
1957	27,689
1958	51,843
1959	70,000**
1960	130,000***

*Year Petrobras was organized.
**Approximate average predicted for year.
***Estimate.

THE AUTHORS

E. CLARENCE ODEN **RINALDO SCHIFFINO**
Petroleo Brasileiro S.A., Rio de Janeiro, Brazil

Petrobras jurisdiction are detailed in Table 2. Those marked "5" operate as independent refineries built before the nationalization act.

For administrative purposes Petrobras has divided the country into petroleum districts similar to those employed by the American Petroleum Institute in the United States. These are shown on the map, which also gives population of each district and location of the individual refineries (marked with stars).

These are by no means the extent of the chemical industry in Brazil. Actually, there are over 255 chemical and pharmaceutical plants now in operation in Brazil employing over 50,000 workers.

Economic Factors Influencing Petrochemical Consumption

Brazil, with a greater area than the continental United States excluding Alaska (3,286,169 square miles compared to 3,022,387), has about a third as much population (65 million according to the last official estimate). This is increasing at the approximate rate of 2.5 percent per year, as against 1.8 percent for the United States and 1.3 percent for the world as a whole. The population is shifting to a more urban and suburban type of living, and major cities are growing rapidly. Sao Paulo and Rio de Janeiro both have more than 3,000,000 population, and Recife, Salvador, Belo Horizonte, and Porto Alegre all have above 500,000.

In the past five years Brazilian industrial production has increased some 6.6 percent, and per capita national income has gone up 3.8 percent. Overall investment in Brazil has increased 72 percent since 1950. Agriculture still predominates, but there is a tremendous national desire to industrialize, and as Brazil industrializes, the opportunity for chemicals increases proportionately.

Motor vehicle output in Brazil in 1959 is estimated at double the 61,082 units produced in 1958, and by 1960 investment in the automotive industry is expected to top $1 billion. The industry will continue to grow by leaps and bounds to meet the demands of the expanding Brazilian economy. Highway construction plans for the period from 1955 to 1965 call for some 8000 miles of new highways.

However, income per family still is low in relation to that in the United States, and the standard of living and extent of industrialization differ considerably. This is reflected in the two nations' consumption of crude products (Table 3).

In forecasting the future of the petrochemical and petroleum processing industries in Brazil, two other important economic factors must be taken into consideration:

1. The high cost of automobiles, which currently discourages use of petroleum products. A new auto in Brazil costs at least two to four times as much as the comparable car in the United States, depending on whether the

TABLE 2. Capacity of Brazil's Refineries in Barrels Per Calendar Day.[1]

Refinery	Ethylene	Propylene	LPG	Motor Gasoline	Solvents	Kerosine	Diesel oil	Fuel oil	Aromatics	Asphalt	Max. rate for full year
Manaus[5]	—	—	80	2,600	—	800	800	900	—	—	4,960
Landulpho Alves (Bahia)[2]	—	—	400	2,400	200	400	900	4,500	—	—	8,650
FCC	—	—	(3000)	(15,100)	—	(7,000)	(6,000)	(17,700)	—	—	(52,000)[8]
Duque de Caxias (Rio de Janeiro)[3]	Under Construction										
When complete[7]	—	—	(1400)	(28,000)	—	(15,000)	(17,000)	(28,000)	—	—	(90,000)
Manguinhos (Rio de Janeiro)	—	—	700	6,000	200	400	300	3,000	—	—	10,600
Presidente Bernardes[4]	200	100	3000	23,000	1000	4,000	14,000	35,000	1000	2500	76,130
Cubatao-Sao Paulo (After Expansion)[6]	(1200)	(130)	(4200)	(24,000)	(1300)	(8,500)	(22,000)	(43,000)	(2100)	(3200)	(110,000)
Capuara[5] (TCC Airlift-Polymerization)	—	—	1700	15,000	—	—	100	10,000	—	—	26,770
Mataraszo[5]	—	—	—	400	100	100	200	200	—	50	730
Ipiranga[5]	—	—	—	3,000	800	400	900	3,400	—	300	9,150
Uruguiana[5]	—	—	—	100	10	10	40	60	—	—	150

[1]All figures are rounded off and indicate approximate maximum capacity, but they do not mean necessarily that maximum amounts of all products could be attained even with ideal crude.
[2]Expanded to operate at 39,000 bbl per calendar day as of January 1960 and has catalytic cracker and lube oil plant. Authorization given to expand to 52,000 bbl and to have catalytic polymerization.
[3]Authorized and under construction.
[4]Expansion authorized. Has thermal cracking and catalytic polymerization. Will have catalytic polymerization and Udex.
[5]Privately owned refinery. Built before nationalization act.
[6]Approximately 600 bbl per calendar day of benzene.
[7]Catalytic cracker to be installed. Also this is location of GR-S plant authorized for construction.
[8]Lube oils and paraffin wax are made at this refinery and represent the difference between 52,000 total and the barrels of other products shown.

car is made in Brazil or imported. This puts a damper on sale of imported automobiles and consequently the use of petroleum products.

2. An unbalanced export-import condition making it necessary for Brazil to carefully guard against excessive imports. High import tariff duties are the method used to control this situation (which incidentally, gives the manufacturer of petrochemicals in Brazil an advantage over the foreign manufacturer selling to Brazil. consumers).

When crude becomes more plentiful and more cars are made in Brazil, the price of cars is likely to decrease, and more petroleum and petroleum products will be sold without hurting the national economy, especially if all products are Brazilian produced. This will generate a demand for better quality gasolines and give impetus to petrochemical expansion, since cracked and catalytically reformed gasolines are needed to produce high octane gasolines.

Moving of the capital from coastal Rio de Janeiro to the new city of Brasilia has stimulated expansion of highways and influx of population to previously sparsely settled regions in the interior. This population movement may progress even faster than the optimistic planners of this bold undertaking for developing the interior of the country actually expected. As the interior develops and good highways become available, the demand for petroleum and petrochemical products should increase sharply.

Brazil's Petrochemical Consumption

It is hardly fair to compare the volume of Brazil's petrochemical consumption with that of the United States, since the countries are so different in population, economy, and industrial development. Brazilian petrochemical consumption may be more readily related to that of France, with about two-thirds the population, and Italy, with about five-sixths as many people . . . and with economies more like that of the Latin American country (Table 4).

Demand for LPG, which is being used for domestic purposes, is increasing at the rate of more than 20 percent per year, or about four times that of other petroleum products. This can be

TABLE 3. Crude Products Consumption in Brazil and United States, Excluding Exports.*

	Brazil				United States			
Product	1957	1958	Est. 1935	Est. 1970**	1957	1958	Est. 1935	Est. 1970
Aviation Gasoline (Imported into Brazil)	6.4	7.2	9.5	11.6	201	206	153	100
Motor Gasoline	61.6	67.8	101.3	124.2	3616	3662	4836	5740
Kerosine (Including Jets)	11.3	12.4	21.9	27.6	295	316	435	470
Distillate (Including Diesel Fuels)	32.0	40.7	69.9	88.9	1691	1775	2286	2597
Residual Fuels	67.6	75.5	104.8	126.1	1505	1438	1796	1992
Asphalt	3.5		[illegible]	[illegible]***	[illegible]	262	380	445
[illegible]	[illegible]	3.8	7.3	8.7	[illegible]	109	135	146
Specialties (LPG, Solvents, etc.)	5.7	7.1	20.2	32.3	1131	1228	1571	2010
	190.1	218.0	339.8	[illegible]	8797	8996	11,592	13,500

*In thousands of bbl per calendar day.
**Predicted by using same percent increase as 1965-1967 shown in Petrobras estimate.
***Predicted by using same percent increase expected in United States.

TABLE 4. Consumption of Petrochemicals.[1,2]

	United States	France	Italy	Brazil Produced	Brazil Imported	Total Consumed
Hydrocarbon Intermediates						
Aliphatic						
Ethylene	4000	72	200	14	—	14
Propylene	4700	36	N.A.	8	—	8
Acetylene	600	N.A.	N.A.	2	—	2
Butadiene	1500	24	45	—	—	—
Aromatics						
Styrene	1230	N.A.	301	12	9	21
Benzene	2700	N.A.	50	11	—	11
Toluene	1400	N.A.	11	2	4	6
Xylenes	1100	16	111	1	—	1
Phenol	600	73	22	18	4	22
Hydrocarbon Polymers						
Polyethylene	700	14	24	14	5	19
Polystyrene	700	24	16	11	—	11
Synthetic Rubber	2000	44	77	—	43	43
Aliphatic Chemicals						
Formaldehyde	540	12	40	9	—	9
Methanol	1700	70	85	29	11	40
Ethanol	1300	N.A.	N.A.	44	—	44
Butanol	1100	N.A.	7	5	1	6
Acetic Acid	600	N.A.	35	180	—	180
Acetone	630	52	10	6	—	6
Ethylene Oxide	1150	40	—	—	—	—
Polyvinyl	800	80	110	17	1	18
Inorganics						
Ammonia	6700	1000	1100	70	—	70
Urea	1000	N.A.	180	—	3	3
Urea Solutions Nitrogen 45%	N.A.	N.A.	N.A.	—	25	25
Other Chemicals						
Carbon Black				31	27	58
Citric Acid				2	1	3
Oxalic Acid				1	—	1
Formic Acid				1	—	1
Phthalic Anhydride				4	—	4
Acetaldehyde				2	—	2
Ethyl Acetate					—	
Butyl Acetate					1	
Sodium Acetate		N.A.		23	—	25
Vinyl Acetate					—	
Octanol				2	1	3
Stearic Acid				11	—	11
Oleic Acid					—	
Glycerine				3	—	3
Methyl Ethyl Ketone				1	1	2
Creosote Oil				7	—	7

[1]All figures rounded to nearest million lb per year.
[2]1957-1958 data.

met by one or more of several possible methods:

1. Installation of catalytic cracking operations.
2. Pyrolytic cracking of heavy naphtha and residual oils.
3. Possible discovery of new natural gas fields, along with exploration for more crude.
4. Processing of shale oil reserves.
5. Making commercial gas from coal.
6. Importing of LPG and exporting of naphtha and residual oil.

The first four methods would increase the supply of raw materials and improve the likelihood of petrochemical industry expansion. More than one of the methods will be needed to satisfy the demand.

Raw Materials

Despite Brazil's fantastic mineral resources a chemical company considering a Brazilian operation may find raw materials a problem. Often raw materials that American firms are accustomed to having supplied must be made right in the plant in Brazil. However, some petrochemical products are available on the local market — some from the steel industry and others from the chemical industry. These include ammonia, ammonia sulfate, benzene, tar, xylene, toluene, ethylene, styrene, butadiene, caustic soda, detergent alkylate, crude sulfur, industrial alcohol, carbon black, some solvents, resins, and naphthalene.

At the present time the United States alone exports some $52,400,000 worth of chemicals annually to Brazil. In addition to this, Brazil brings in millions of dollars worth of chemicals from Germany, England, and other countries.

Expansion of the basic industries and their growing need for chemicals, coupled with the rising dollar shortage in Brazil, points to a wide-open market for those chemical companies with manufacturing plants operating in Brazil.

Potential Petrochemical Consumption

Fertilizer consumption is small in Brazil and all other Latin American countries in relation to that in the United States, Europe, or the heavily populated area of Japan (Table 5). However, with the modernization of farming and the industrialization of Brazil, fertilizer consumption undoubtedly will increase rapidly, and more and more agricultural products will be exported.

TABLE 5. Fertilizer Consumption.

Area	Lb Per Acre	Lb Per Capita
Brazil*	Less than 7.0	6.3
Latin America	5.3	7.5
United States	26.0	62.5
Europe	50.0	45.5
Japan	124.0	21.1

*Brazilian consumption was calculated as the sum of Nitrogen, P_2O_5, and K_2O. Other figures were calculated on the same basis, as best could be determined from the literature.

The plastics industry has tremendous potential, but present consumption is low when compared to that of Italy or France and far below that of the United States. Since concrete is the most commonly used building material, a ready market is waiting for plastic floor covering for the concrete.

The synthetic fiber industry has a large potential market in nylon and polyester fibers. Brazil has a warm climate, and the humidity is high around the coastal areas where most of the population now lives. A synthetic fiber that is mildew, moth, and wrinkle resistant, and preferably washable — such as some of the polyester fibers are — should do well here. Import duties on these fibers or the manufactured materials are apt to remain high, so the real solution to this problem is to manufacture the materials in Brazil.

The tire cord industry could grow into a fair size industry for nylon because of replacement of tires for trucks and cars. While heavy equipment tires used in road building probably will not be manufactured in Brazil to any large extent for some time, automobile tires are now manufactured there. Cotton cord is still used, but nylon cord manufactured in Brazil is likely to replace this soon. Benzene, hydrogen, and butadiene will soon be available in large quantities in Brazil as raw materials.

Manpower

Industrial development requires carefully trained scientific manpower, and this is being provided for the Brazilian petrochemical and petroleum processing industries by Petrobras, which about five years ago set up a unique technical training program. A total of 127 college graduates has had the post graduate training course in refinery operation, design, and maintenance, and more are now in school.

The program recently was expanded to train a group of men in the highly specialized petrochemical field of synthetic rubber. They include personnel who previously had gone through the refinery training program. In addition, these men had completed about two years of on-the-job training in refining, ammonia fertilizer production, and shale oil work.

Operating departments of the refineries and government trade schools are cooperating to train mechanical craftsmen. They receive on-the-job and in-school training on a cooperative basis somewhat similar to the cooperative training programs offered by engineering colleges in the United States.

Incentives to Industry

Foreign capital is invited and treated well in Brazil. President Kubitschek included in his economic development program for Brazil an invitation to foreign capital, and to make it more attractive offered certain incentives to new industry. Among the more important of these is the offer to allow all, or at least a major share, of vital new industries, plant equipment, and machinery to be brought in duty free. Naturally, any part of the equipment that must be bought new and could be purchased in Brazil must be purchased there or pay heavy import duty. But if it is not available in Brazil, or the equipment is actually part of an old plant, by meeting certain standards it may be brought in duty free. Long term loans at low interest rates and tax benefits for new industries are two more incentives offered by the Brazilian government. The government has at times sponsored the production of certain needed raw materials for chemical and other manufacturing companies when these materials were extremely expensive or scarce.

In conclusion, the future appears bright in Brazil for companies seeking opportunities for capital investment in the petrochemical industry. The people of Brazil have a deep desire to industrialize the country, and Brazil's largest city, Sao Paulo, shines as a good example of how much industrialization can mean to an area. ★ ★ ★

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Mobil Oil de Venezuela's

El Palito Refinery

Petro/Chem's Plant Pic/Trip

MOBIL OIL DE VENEZUELA'S first refinery is now producing gasoline, kerosine, diesel fuels, residual fuels, and jet fuels at El Palito, near the Caribbean port town of Puerto Cabello.

The 50,000 bbl per calendar day refinery, engineered and constructed by The M. W. Kellogg Company, is made up of three process units — crude distillation, catalytic reforming, and product treating.

The crude distillation unit is designed to process 28.4° API Barinas oil at a maximum charge rate of 55,600 bbl per stream day. The gas recovery section consists of three main towers — straightrun gasoline stabilizer, depropanizer, and gasoline splitter. An important engineering economy provides that heat for reboiling the streams in the splitter and stabilizer towers is supplied by circulating the intermediate reflux stream from the atmospheric tower.

Naphtha from the crude unit goes to the catalytic reformer, designed for a capacity charge of 6500 bbl per stream day, and is reformed into stabilized reformate and fuel gas by compressing with hydrogen in the presence of a catalyst. Physical sections of the unit consist of three reactors where the naphtha is actually reformed, a four-section furnace, and a stabilizer.

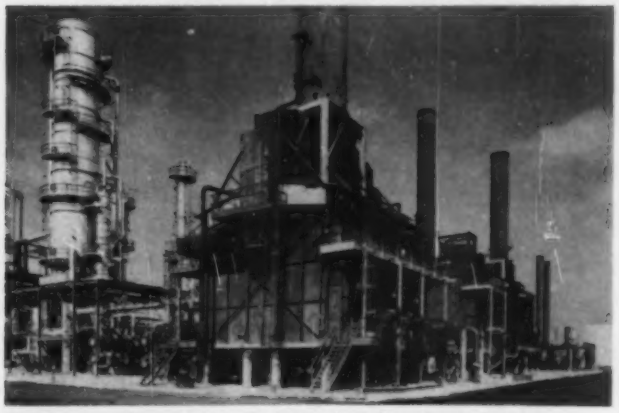
Feed naphtha is charged directly from the gasoline splitter tower of the crude unit with hydrogen-rich gas through a preheat exchanger and then to the first furnace section. Next, the stream flows into the first of three spherical reactors. To minimize utilities investment, the reciprocating recycle compressors pro-

Process area as seen from the water purifying area, showing furnaces, crude and light ends recovery towers. Reformer stabilizer tower and treating tanks are at far right.

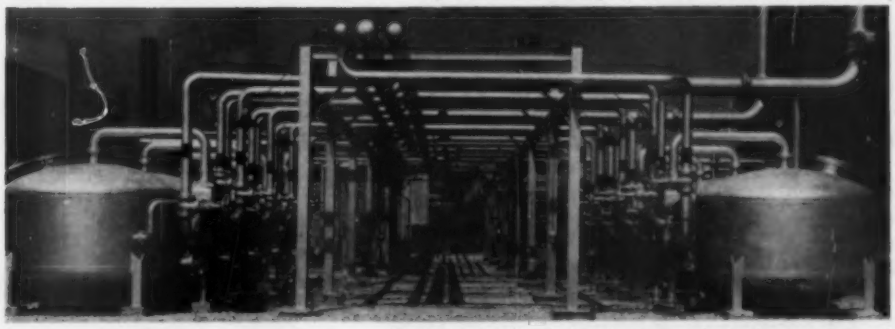
Punctuating the skyline are the crude tower — tallest in the refinery — and the stabilizer and depropanizer towers.

Reformer gas compressors, right, and reformer stabilizer tower are part of the crude unit's gas-recovery system.

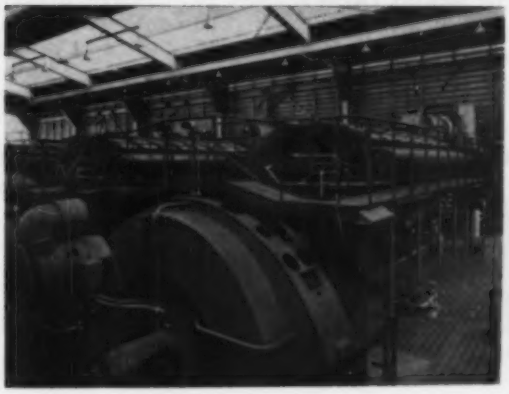
Crude tower and furnaces and reformer furnace. The latter combines reforming and reboiling in its four compartments.



This view shows vessels, piping, and cooling tower, far right, of water cooling system for refinery's process units.



Refinery's diesel electric power plant, showing three of four engines shipped to Venezuela from the United States.



vided for the reaction are gas-engine driven. The reformer is designed to operate over a range of reforming severity depending on the product characteristics desired. Special provisions were included for a low-pressure flash separation of the reactor product.

Kerosine, butane, and light straightrun gasoline from the crude unit go to the caustic and water-wash treaters and then to either blending or storage.

The refinery's gasoline-blending system is uniquely designed to blend three grades of gasoline in blocked operation, although each grade is basically composed of light straightrun gasoline, catalytic reformate, unreformed naphtha, and butane.

Cost of the complete refinery project, including a separate 750-bbl per day capacity lube oil blending plant, marketing facilities, a diesel-electric power plant, an administration building, and a special fresh-water collection system, is estimated at $30,000,000.

Oakite ECP
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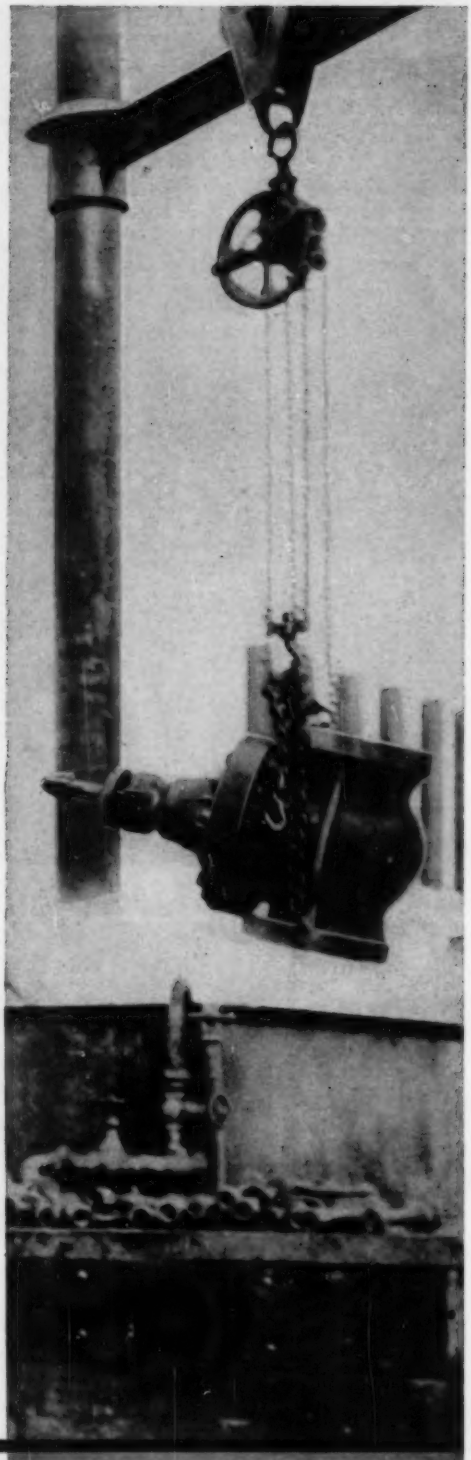
turns parts salvage into a BIG source of savings



Salvage cleaning of flanges, fittings, valves and other parts formerly took up to 22 hours a batch at one refinery. Heavy deposits of grease, paint, oil and rust were being stripped with a cold solvent. The effort seemed hardly worthwhile.

But in developing an ECP for the refinery, the Oakite engineer included a recommendation to install a permanent salvage cleaning set-up. Now, parts reclamation is a strong contributor to cost control. Work moves as in a "production line"....through special Oakite solutions. Stripping even the worst of soiled batches to bare metal takes only an hour and a half... while material costs have been cut from $1.90 a gallon to less than 58 cents!

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CONDENSER AND HEAT EXCHANGER CLINIC

Edited by David S. Hibbard, Metallurgical Engineer
The American Brass Company, Buffalo 5, New York

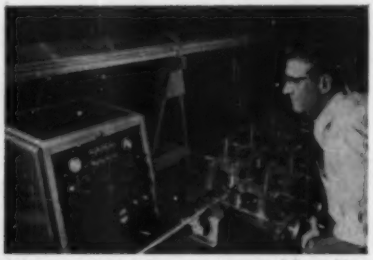
New controls and services meet increasingly critical requirements in heat-transfer units

As steam cycles in turbines become more complex—and operating temperatures and pressures rise—the job of the heat-transfer equipment becomes increasingly critical. Nuclear energy plants place tremendous emphasis on continuity of service for even conventional components like condensers. And in many processing plants the cost of shutdowns may range from exorbitant to disastrous.

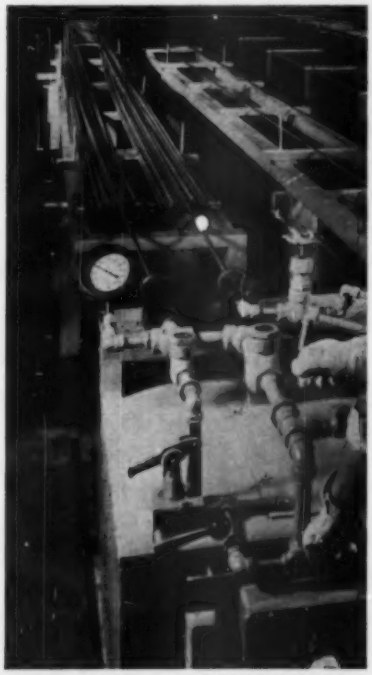
Assurance that tubes will meet service requirements becomes increasingly important. And The American Brass Company has augmented its normal quality controls with tests and services to help makers of heat transfer equipment prevent possible trouble before it starts.

Electronic inspection. All tubes are inspected visually one at a time, both internally and externally. However, where greater assurance is required, the tubes—in straight lengths up to 100′—can be inspected electronically by eddy-current equipment.

All tubes are inspected visually one at a time, both externally and internally.



When required, tubes are inspected by eddy-current equipment, located at the tube straightener.



All U-bend tubes are tested hydrostatically at ASME Code pressures—or higher, if necessary.

Hydrostatic testing. As most U-bend tubes are used in applications involving high temperatures and pressures, all of these tubes are tested hydrostatically—after bending—at ASTM Specification pressures. They can, however, be tested at ASME Code pressures, up to 6000 psi, on request, if the tube size is such that it will withstand the pressure.

Relieving stresses. All U-bend tubes, other than copper, are annealed at the bend area after bending, to eliminate the hazard of stress-corrosion cracking which might occur in service due to stresses that may exist as a result of the bending.

Duplex tubes are widely used in chemical plants and petroleum refineries to meet diverse combinations of corrosive action and/or pressure and temperature. Recently designers have selected them for use in air-removal sections of electric-power-plant condensers where corrosion is very severe.

Broadest service. In helping manufacturers and users of heat-transfer equipment meet day-to-day problems, The American Brass Company has a broad background in the latest developments in heat-transfer equipment's expanding role. And with new mill equipment now in place, it offers the broadest service available in tubes for heat-transfer equipment. For technical assistance in special problems, write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

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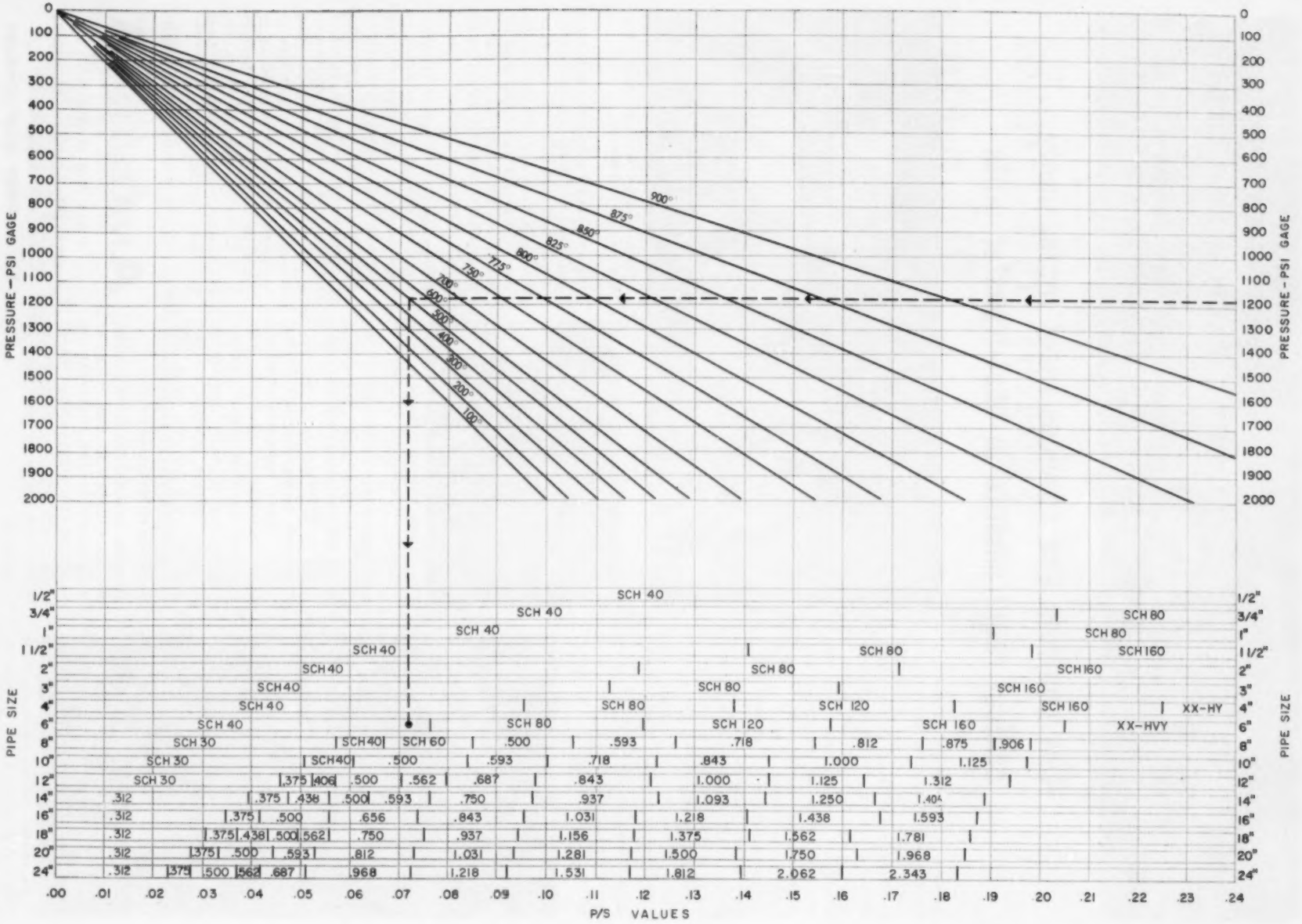
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P/S VALUES

Time-Saving Chart

For Pipe Wall Thickness Selection

W. P. HANSEN
Chief Piping Engineer
The Fluor Corporation, Ltd., Houston, Texas

WHEN YOU ARE DESIGNING piping systems, use this chart to obtain correct wall thickness. The chart will save you the time it takes to make multiple arithmetical calculations, if they are not required for permanent job records. If calculations are required, the chart offers a quick, independent check that usually eliminates 90 to 95 percent of the checking time needed to make the calculations.

The chart is based on ASA-B-31.3, Refinery Piping Code, 1959 Edition. It was prepared for ASTM-A-53 Grade B and ASTM-A-106 Grade B Seamless Pipe, with a corrosion allowance of zero, and y equaling 0.4 (Modified Lamé Formula).

Here is how to use it:

Start with the design temperature and pressure. Enter the chart with the design pressure and travel horizontally until the design temperature is intersected. Then drop vertically to the proper size bar. The wall thickness or schedule as specified at this point is that required for the specific conditions in question.

When a corrosion allowance is required, use the chart as outlined but read the P/S value as well. Compare the P/S value read from the chart with that as taken from Tube Turns Engineering Bulletin TT-698, Pressure/Stress Ratios, under the particular corrosion allowance desired. If the value read from the chart is less than that specified by the Tube Turns paper for corrosion, the pipe wall is satisfactory as read. If not, use the next heavier wall or schedule.

How to construct your chart:

The chart is based on this equation for pipe wall thickness:

$$t = \frac{PD}{2S + 2yP} + C$$

Where:

t = Minimum design thickness

y = 0.4

S = Allowable stress

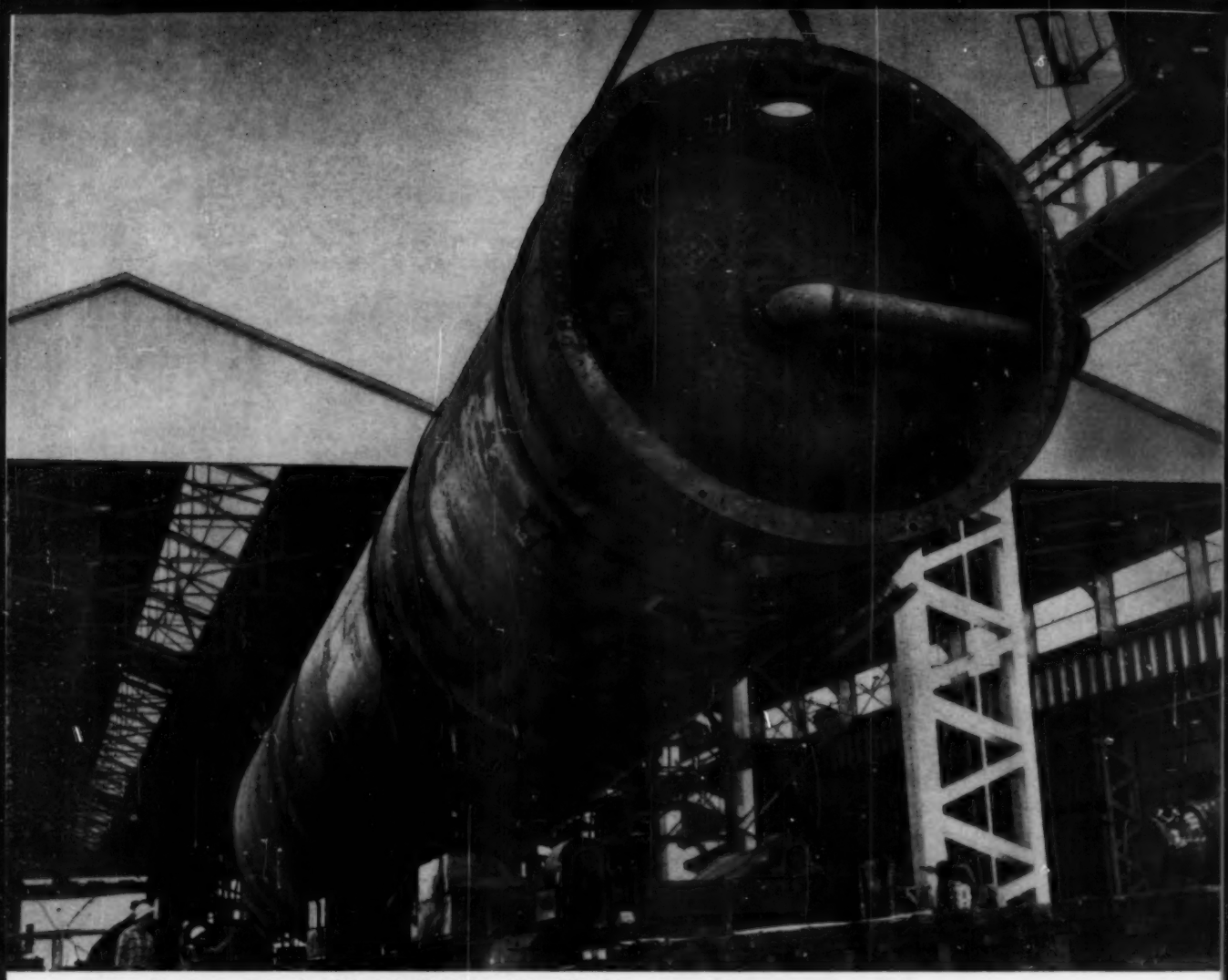
P = Design pressure

D = Outside diameter

C = Corrosion allowable and/or thread depth

To prepare charts suitable for design materials other than those given here (ASTM A-53 B and A-106 B), proceed like this:

1. Lay out pressure, using any scale, from 0 to highest desired pressure.
2. Lay out P/S value, using any scale, from 0 through a desired range. These P/S values are readily obtained from Tube Turns Engineering Bulletin TT-698.
3. The background of the chart will indicate pressure to P/S value.
4. By using the allowable for the material desired and a series of pressure points, various points can be calculated and would be used to construct temperature lines.
5. Pipe size bars can be drawn on chart, and the maximum P/S for each pipe size and wall thickness as taken from the Tube Turns paper can be plotted.



Designed by the Fluor Corporation, Ltd., for the Union Texas Natural Gas Corp.

It took a stork's big brother to deliver this 225-ton baby

High-capacity cranes were needed to handle this giant absorber unit (225 tons, 56′ long, 4″ shell), that required special attention and equipment all along the way. First, it was made of ASTM A212 Grade B Firebox Quality Plate, charpy impact-tested to 15 ft. lbs. @ —50°F. Then it was flame cut and roll formed. Its main stem was 100% radiographed, and its nozzle penetration was magnetic-particle inspected. The entire vessel was then stress relieved at 1150°F. for four hours. And finally, it was placed on special flat cars for delivery. ☐ This kind of job demands the complete, modern, high-capacity facilities that permit our Orange, Texas plate shop to handle all kinds of custom plate work. High-capacity cranes, mammoth car bottom furnaces, giant presses and bending rolls, the latest in welding equipment, and complete inspection facilities. This plus know-how and strategic location permit us to produce all kinds of plate work efficiently and economically. And anything we make, we can erect.

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USS

mathematics workshop

Dr. J. M. Marchello, *Oklahoma State University*

ALGEBRA | *part 1*

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PETRO/CHEM

WHEN YOU START SOMETHING the best place is at the beginning . . . so we will kick off our Mathematics Workshop with algebra and go on from there. The series will offer you a rather rapid review of algebra and analytic geometry. Then it will go into calculus and differential equations and finally into operational calculus.

Petro/Chem Engineer's math workshop is intended as a refresher course in APPLIED MATHEMATICS. This means the theory and mechanics will be presented and their applications discussed in detail. Keep in mind that this material is presented for you . . . the practicing engineers of the hydrocarbon processing industry, and we hope it will serve a definite need.

As you know, algebra is primarily an extension of arithmetic. The principal difference is the use of letters as symbols, in addition to Arabic characters (1, 2, 3, etc.), and the general use of equations.

A. The Number System

The number system is the basis of modern mathematics. As mental concepts used to count the objects in various assemblages, numbers make no reference to the characteristics of the objects counted. For example, the number five is an abstraction of all actual collections containing five things, as such, it does not depend upon any specific qualities of these things or on the symbols used.

Arithmetic is the mathematical theory of positive integers. It is based on the fact that the addition and multiplication of integers are governed by certain laws.

In the number system of algebra the positive integers of arithmetic are only one of several sets of numbers which make up the whole number system. Algebraic numbers include integers, fractions and repeated decimals, zero and imaginary numbers.

B. Variables and Functions

The major portion of modern mathematics centers around the concepts of functions of variables. If a plane is projected or topologically transformed, the coordinates of a point in the plane after the transformation are functions of, i.e. depend on, the original coordinates of the point. The concept of function arises whenever quantities are connected by a physical relationship. For example, the volume of a gas enclosed in a cylinder is a function of the temperature and pressure on the piston.

Frequently, it is possible to choose an object, X, arbitrarily from a whole set of S objects. Then such an object is a variable within the range or domain S and one says that, "the variable X ranges over the set S." For example, X might denote any member of the population S of a given city at a given time. In the important case of a numerical variable which has a range of variability in an interval $a \leqslant X \leqslant b$ of the real number axis, one speaks of X being a continuous variable in the interval.

When a definite value of a variable u is associated with each value of a variable X, u is said to be a function of X.

$$u = F(X) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

If X ranges over the set S, then u will range over another set determined by the functional relationship between u and X. In Equation 1 X is the independent variable and u is the dependent variable, since its value depends on the value chosen for X.

Often the character of a function is most clearly shown by a geometrical graph. If X, u are the coordinates with respect to a pair of perpendicular axes, then in the X-u plane linear functions such as

$$u = aX + b \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

are designated by straight lines; quadratic functions such as

$$u = a + bX + cX^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

are shown as parabolas; the function

$$u = \frac{a}{X} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

is represented by a hyperbola, etc. The graph of a function $u = f(X)$ consists of all the points in the plane whose coordinates X, u are in the relationship $u = f(X)$.

In the same manner that a graph may be used for the geometric representation of a function

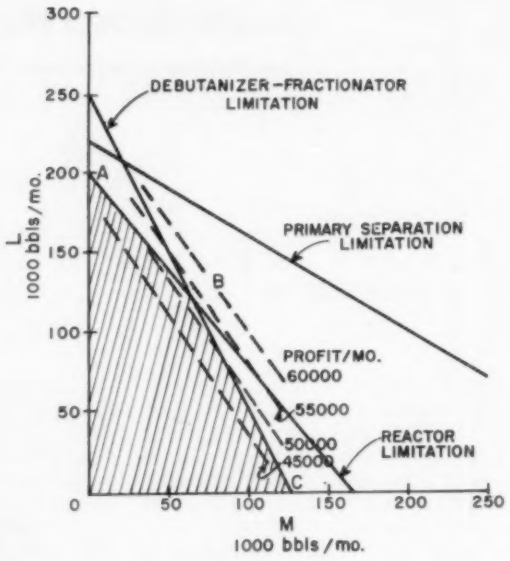

FIG. 1. Determination of optimum production rate for an alkylation plant.

of one variable, a geometrical representation of a function, $u = f(X,y)$, of two variables is given by a surface in the three dimensional space with X, y, u as coordinates.

PROBLEM 1

Optimum Operation of an Alkylation Plant

An alkylation plant is capable of producing both a light and medium alkylate simultaneously. Gasoline blending requirements for these two product streams are such that the total plant capacity of either light or medium alkylate, or any combination of the two is required. During a month of production the barrels of light alkylate L, and medium alkylate, M, that can be made are restricted by the capacity of the various units of the plant as follows:

The reactor cannot produce more than 200,000 bbl of light alkylate or more than 160,000 bbl of medium alkylate per month. That is, reactor production of a barrel of medium is equivalent to producing (200000/1600000) = 1.25 bbl of light:

$$L + 1.25\,M \leqslant 200{,}000 \quad . \quad . \quad . \quad . \quad . \quad (1\text{-}1)$$

The primary separations unit cannot handle more than the equivalent of 220,000 bbl of light alkylate per month. This initial separation for a barrel of medium is equivalent to that of separating 0.60 of a bbl of light:

$$L + 0.60\,M \leqslant 220{,}000 \quad . \quad . \quad . \quad . \quad . \quad (1\text{-}2)$$

The debutanizer-fractionator unit cannot handle more than the equivalent of 250,000 bbl of light alkylate per month. This final separation for a barrel of medium is equivalent to that of separating 2.0 bbl of light:

$$L + 2.0\,M \leqslant 250{,}000 \quad . \quad . \quad . \quad . \quad . \quad (1\text{-}3)$$

Any production program of light and medium alkylate streams satisfying the above restrictions is feasible. Assuming that the "profit" for light alkylate is \$0.25 per bbl and the profit for medium alkylate is \$0.35 per bbl, then the total profit, P, per month is given by:

$$P = 0.25\,L + 0.35\,M \quad . \quad . \quad . \quad . \quad . \quad (1\text{-}4)$$

The question now is what production program maximizes the profit?

Solution:

If the monthly production of medium alkylate is plotted on the abscissa and the production of light alkylate on the ordinate, Fig. 1, the above restrictions imply that all feasible production rates must lie within the simplex, (shaded area) OABC. The primary separations unit, Equation 1-2, places no restriction on the production and actually contains a fair amount of excess capacity. The reactor, Equation 1-1, places an upper limit on production as represented by the boundary line AB. The debutanizer-fractionator unit, Equation 1-3, also restricts production as shown by the line BC.

Equation 1-4 is represented as broken lines on Fig. 1 for various constant values of the profit. This relationship contains three variables; P, L, and M, and is shown on the two dimensional L-M plot as a series of lines with the third variable, P, as a parameter.

The maximum feasible profit is a line which contacts the operating area, OABC, and has the largest value of the profit, P. This occurs at the point B and represents a profit of \$52,500. Maximum profit is obtained when 116,666 bbl of light and 66,666 bbl of medium alkylate are produced per month.

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A discussion of an installation providing electrical . . .

emergency power for refineries

J. M. CROTHERS MORTON GOREN
Catalytic Construction Company, Philadelphia

IMPORTANT PROCESS UNITS in modern refineries require that the electrical system be thoughtfully designed and the components carefully chosen for long onstream periods and high productivity. Dual distribution systems, alternate feeders and loop systems are used to advantage. Certain failures, either within the plant or of the utility supply, causing partial or complete outages result in loss of production and usually require a long time to get back to onstream conditions. Safe, controlled shutdowns can usually be accomplished with emergency electrical power.

Study Each Case

The primary factor in determining the advisability of an emergency installation is the total cost in relation to the accumulated savings afforded by maintaining full or partial production and reducing the time to return to onstream operations during power failures. Infrequent power failures of short durations, not causing complete shutdown, will not usually justify such an expenditure. Frequent power failures, particularly long ones, will undoubtedly more than justify such an expenditure. Infrequent power failures of long duration should be carefully considered. A study of past records with present-day cost figures will assist borderline case decisions.

While steam generally is available in most refineries and essential motor driven pumps are spared by turbine driven pumps, the question of having light and keeping a careful check on levels, temperatures, flows, annunciators and the ability to control specific essential operations at remote points, can be answered by emergency power.

What Is Best Source?

Standby banks of batteries have been installed in some plants which supply emergency lights. They require con-

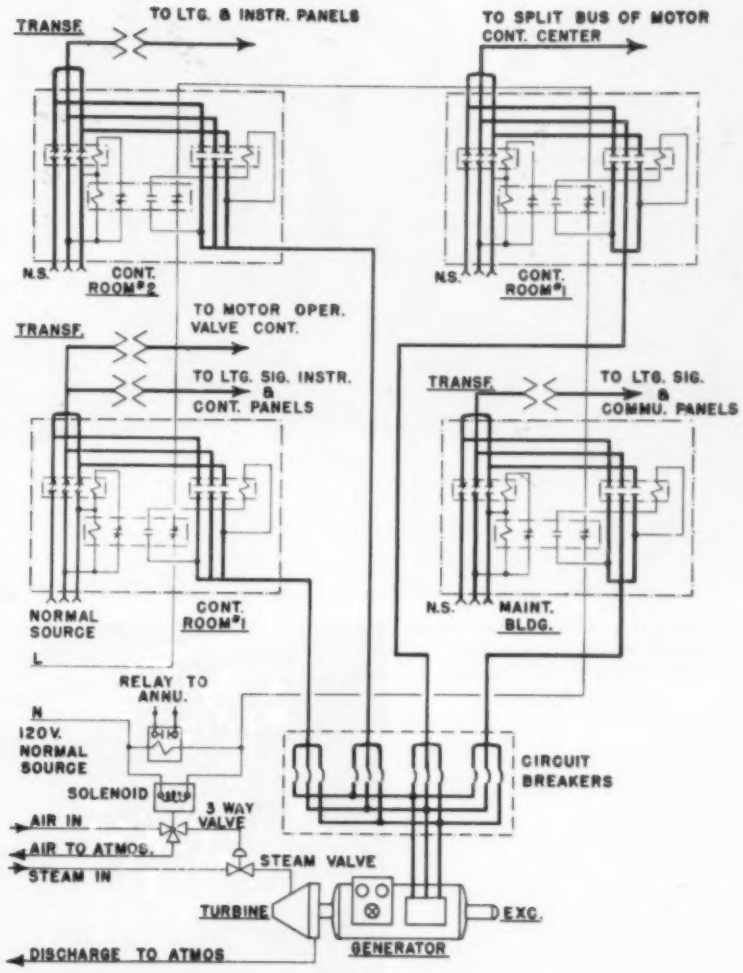
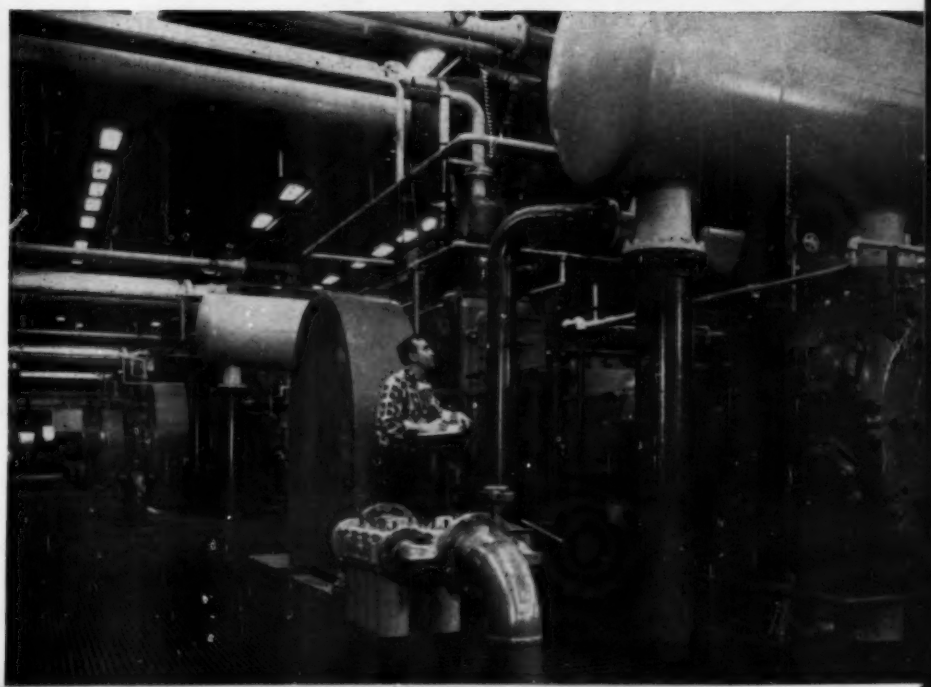


FIG. 1. Typical wiring diagram.

Cooper-Bessemer compressor shown is one of two units for compression of synthesis gas.



View showing the four Cooper-Bessemer compressors. Unit in foreground is for "mixed gases" (air, nitrogen and methane).

Henry LaRue, *Ammonia Area Superintendent, Spencer Chemical Company, Vicksburg, Mississippi explains...*

How we compress four different gases with a team of four Cooper-Bessemer compressors

"Our entire ammonia plant depends on the uninterrupted flow of component gases, compressed by four Cooper-Bessemer GMW-8 Compressors," reports Mr. LaRue. "These four 2000 hp gas engine driven units have been the heart of our system 24-hours a day, day in and day out, since 1953.

"Two of the compressors, with five cylinders each, compress three different gases... air, nitrogen and methane. The other pair of compressors pump a synthesis gas mixture of hydrogen and nitrogen.

"Despite their 'round-the-clock operation for seven years, none of these Cooper-Bessemer compressors has had a major down-time for maintenance. They represent a sound investment."

Cooper-Bessemer engineers are at your service to help you plan compression and power facilities. Call the nearest office.

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ENGINES: GAS • DIESEL • GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL, ENGINE, TURBINE OR MOTOR DRIVEN

stant maintenance, create possible corrosive gas and will not operate control circuits, motors, relays, solenoids, alarms, or synchronous motor driven instrument charts using alternating current. Diesel generators have also been installed in plants where steam is not available. These are large for the horsepower ratings, costly, hard to start unless kept heated and costly to install according to fire protection regulations. In refineries it is usually advantageous to install a turbine-generator with a solenoid operated pneumatic steam valve which automatically opens when the solenoid is de-energized.

Here Is An Actual Case

A description of a recent installation requiring both three and single phase emergency power shown by wiring diagram, Fig. 1, will illustrate the design and component parts of this system. Many variations of this design can be made and separate parts can be utilized to fit almost any emergency power problem. This installation serves three phase, 60-cycle power to six small 440-volt motors, 220-volt motor operated valves and 120-volt, single phase, 60-cycle to separate panelboards for lighting, signal systems, all control and indicating systems, annunciators, recording instruments, communications and aircraft warning lights.

The decision to provide emergency power for the motor operated valves was due to the necessity for speed of operation and because their various locations made quick manual operation practically impossible. The 120-volt control, indicating the alarm systems for these valves are located in control room No. 1 on the instrument panelboard, so that complete emergency operation of the valve system can be performed from one location. The six 440-volt motors are started and stopped from the control rooms and their emergency operation provided a safe, better controlled shutdown.

Load Requirements

The size of the turbo-generator was determined by load requirements of the maximum number of motors starting simultaneously, plus the emergency lights, plus an estimated instrument and control load, plus an estimated load for possible future additions. Careful consideration of the generator capacity should be made, realizing the difference between transformer voltage regulation and generator voltage regulation. This regulation should be capable of sustaining contactors and relays during maximum starting current demands. Low or slow generator voltage regulation will result in hunting effects.

Turbine — Generator

This generator is the so-called "packaged" type, 100 kw, 480-227-volt, 3-phase, 4-wire, 60-cycle, 0.8 power factor, 1800 rpm, with revolving field, damping transformer, built-in voltage regulator, direct connected exciter, manual rheostat, ammeter and voltmeter. The turbine is a single stage, 450 psig, reversing chamber, radial reentry, velocity compounded type.

System Controls

Control is by a speed-responsive hydraulic governor. The turbine speed of 1800 rpm was chosen to match the generator, eliminating reduction gears and high speed. Turbine efficiency and steam loss is of little consequence so the turbine is discharged to the atmosphere as its operation is infrequent. A pneumatic diaphragm valve with a three way, manual reset, air control solenoid valve controls the steam to the turbine. The coil of the solenoid is energized from a normal 120-volt circuit, holding instrument air on the diaphragm keeping the steam valve closed. On failure, the solenoid de-energizes venting the air off the diaphragm to atmosphere through a variable orifice controlling the rate of speed of opening. This permits a smooth increase of steam to the turbine rather than a sudden inrush which would result in overspeed and overvoltage. On return of normal power, the solenoid remains tripped or de-energized and the turbine keeps running until the solenoid is reset by the operator. This prevents cyclic operation of the set due to sudden power fluctuations. A small manual steam valve is installed to by-pass the pneumatic steam valve which allows sufficient steam to keep the turbine heated and turning slowly, ready for immediate service.

Small turbo-generators of low pressure steam, up to and including 25 kw need not have pneumatic steam valves. The momentum of the smaller revolving mass is not beyond the ability of the control of the speed governor and a straight solenoid operated steam valve can be installed. It should be remembered that a few seconds are required to bring the generator to the designed voltage. During those seconds, contactors, relays, solenoid trips, such as those at the still heaters, airline burners, etc., will drop out and the operators must reset certain equipment.

Small units, similar to the 50 kw set shown in Fig. 2, including the valves and feeder circuit breakers, can be located in back of the instrument control boards. Large units can be located in a switchgear or starter room. Both should be near an outside wall in order to reduce the length of steam piping. All units should be operated periodically to insure serviceability.

ABOUT THE AUTHORS

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MORTON GOREN

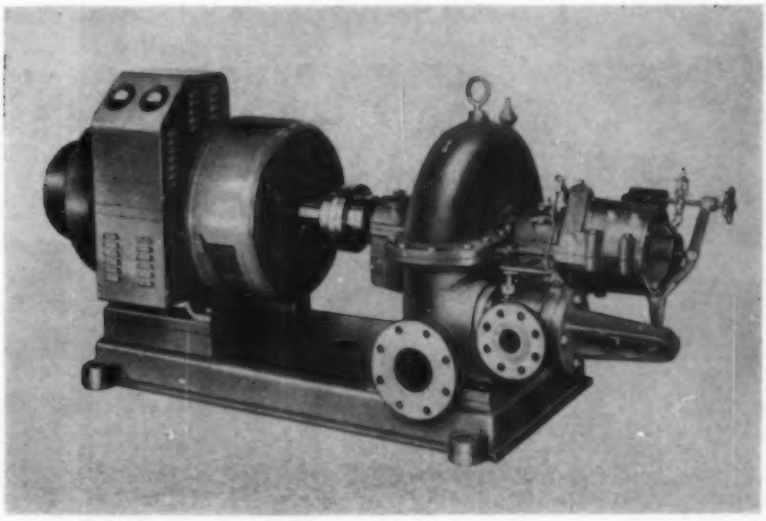


FIG. 2. 50-kw turbo-generator set.

Wiring and Operating Sequence

A complete wiring diagram is shown in Fig. 1 except the manufacturer's wiring for the "packaged generator." All equipment is shown with the normal source energized. The generator leads are brought out to a 440-volt, 3-phase power distribution circuit breaker panel, located adjacent to the generator. Here the system is divided into four sections due to their locations, loads and maintenance. The 70-ampere breaker supplies control room No. 1 providing emergency power for the lights, motor-operated valve system and other essential systems including signals, instruments and aircraft warning lights. A 30-ampere breaker supplies control room No. 2 for lighting, signals and instruments. A second 30-ampere breaker supplies 480 volts to a split motor control center to provide emergency power to six small essential motors totalling 11 hp. A third 30-ampere breaker supplies emergency lighting and communications to the maintenance building which also contains the offices, a small laboratory and storage space. Four automatic transfer switches with their relays are located in the respective building where each has its normal source. These automatic transfer switches are obtainable in various voltages, phases and capacities and are very reliable. 480-volt, 3-phase, from both the normal source and the emergency source, are connected to the line side of the respective 480-208/120-volt, 3-phase, 4-wire secondary transformers to serve lighting, instruments, etc. The motor operated valves are fed through a separate 480-240-volt, 3-phase transformer. The 440-volt, 3-phase motor bus is fed directly.

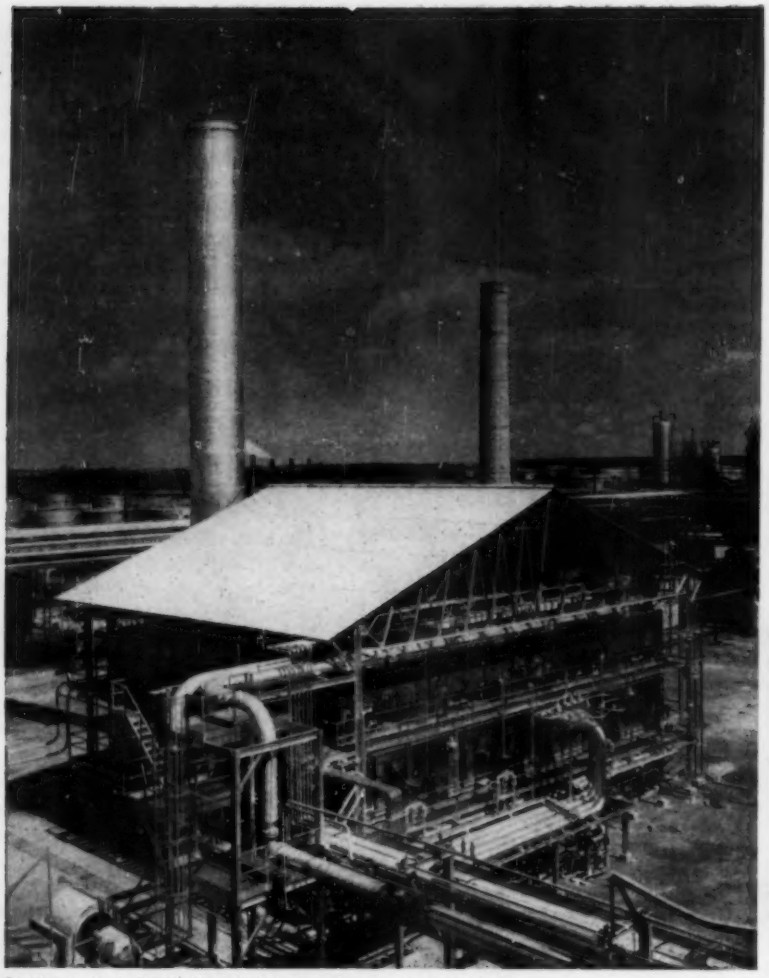
The most important sections of the process are controlled from control room No. 1, such as still heaters, burners, motor-operated valves and all associated controls and instrumentation. The normal 120-volt source is used for the emergency turbo-generator solenoid valve. The phase line of this circuit is connected in series through the closed contact in the auxiliary relay of each automatic transfer switch, then to the solenoid coil to neutral. During normal energized conditions these contacts are closed and the solenoid is energized. On loss of normal source to any automatic transfer switch, this series circuit opens, trips the solenoid and the turbo-generator starts, the normal contactor opens and when the correct voltage is generated the emergency contactor closes, supplying emergency power to that section. This system supplies any or all sections as required. A small relay is connected in parallel with the solenoid valve coil to indicate that the turbo-generator is running so that the head operator in the control room No. 1 is informed and can take the proper action.

Many variations of this system can be developed. For example, one project had no need for 480-volt service. The motor-operated valves were made 208-volt, 3-phase, so the generator was 208/120-volt, 3-phase, 4-wire and the emergency feeders were connected through the automatic transfer switches to the load side of the lighting and instrumentation transformers, directly into the 208-120-volt, 4-wire distribution panelboards. Other installations consisted of 10 to 50 kw, 120-volt, 3-wire, single-phase generators and one or two automatic transfer switches.

In any emergency power installation the design should incorporate the minimum number of relays and contactors and a simple, dependable turbo-generator unit. Complications should be avoided in order to obtain the quick, reliable performance required during power failure conditions. When the lights go out and pressures, temperatures, flows and levels are unpredictable, damage can result to both equipment and personnel. An emergency installation providing power to automatically serve sufficient lights, important recording and indicating instruments, the alarms and communications and essential process controls will be a valuable factor in controlling unscheduled shutdowns and greatly reducing the time of return to onstream conditions. ★ ★ ★

Adapted from a paper given by the authors at the 1958 Petroleum Industry Conference of the American Institute of Electrical Engineers, Dallas, Texas, September 1958. Permission of the AIEE to publish this paper is gratefully acknowledged.

DISCUSSION INVITED . . . the authors of papers appreciate comments and discussion from the readers. Please address your replies . . . for publication or to be directed to the authors . . . to **J. C. Webb, Editor, P. O. Box 1589, Dallas 21, Texas.**



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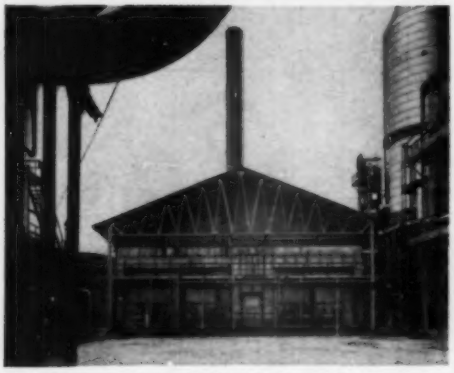

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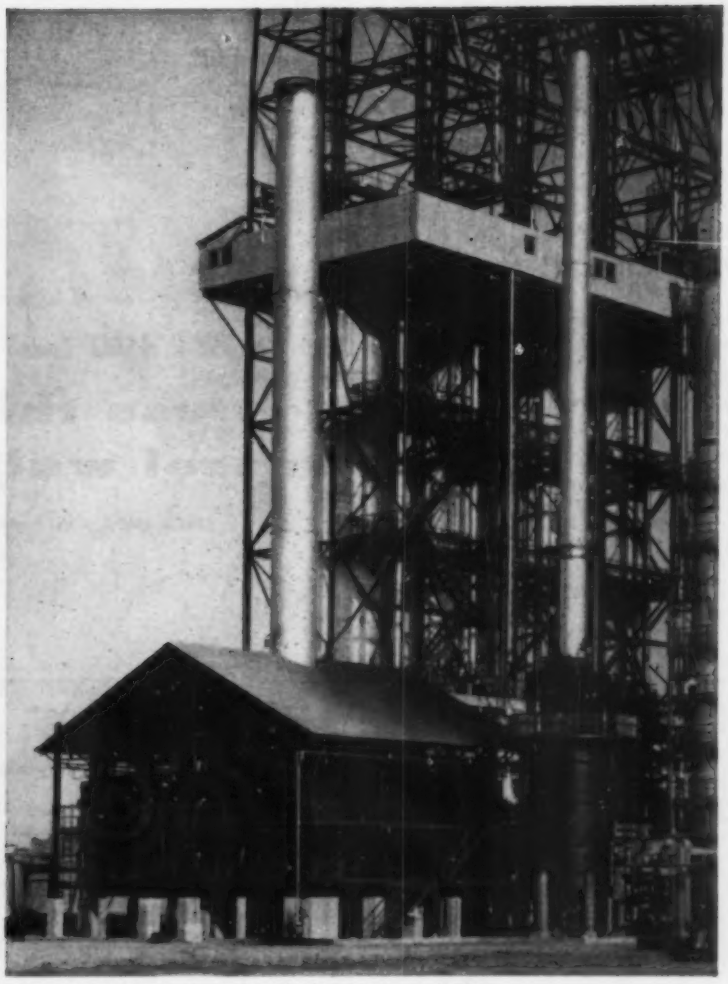

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In Accordance With the 1959 ASME Code...

use this chart for vessel wall thickness

DICK ENOS, *Chief Engineer, Trinity Steel Company Inc., Dallas, Texas*

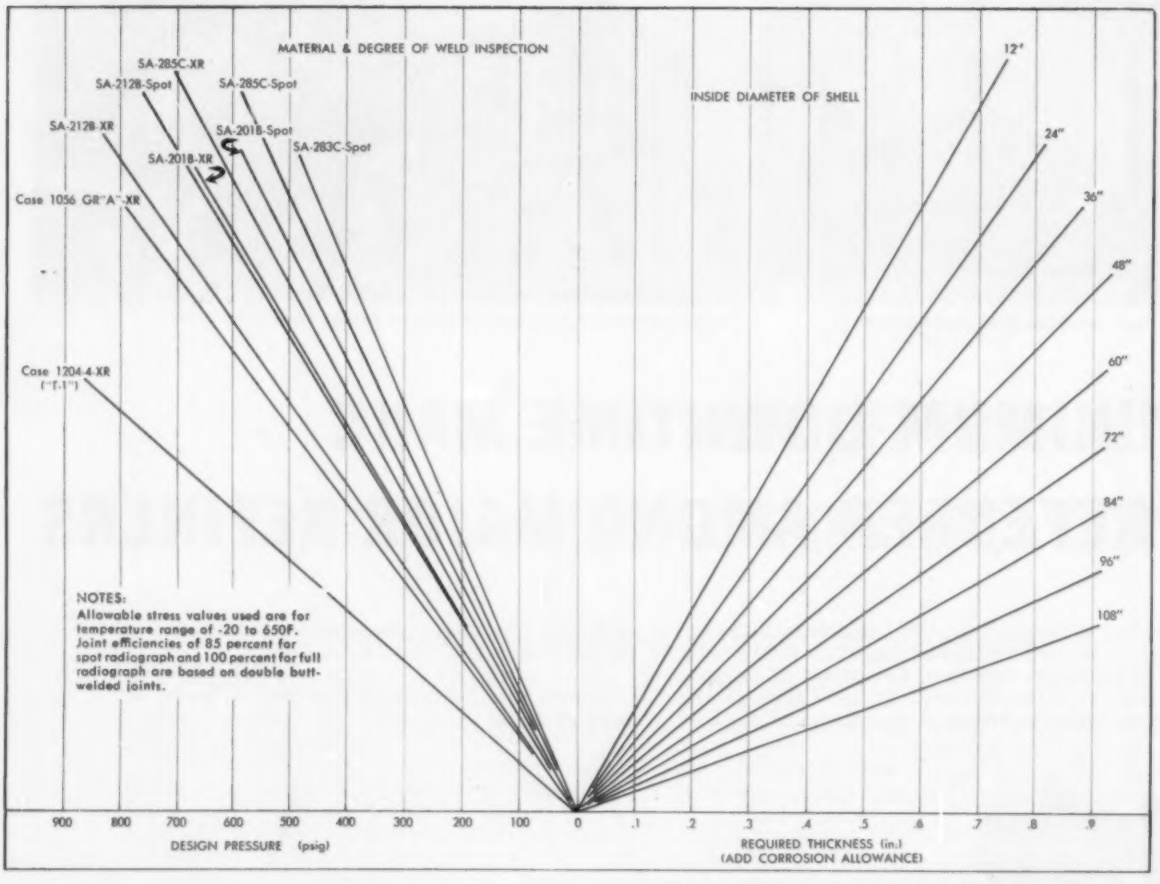

FIG. 1. Estimating chart for vessel wall thickness ... enter chart at design pressure and travel vertically to appropriate curve for desired material. Proceed horizontally to the inside diameter of the vessel and then drop down to the wall thickness. This chart is an aid in visualizing the effects of radiographic examination and/or the use of higher quality steels.

IN March of 1959 the **ASME Boiler and Pressure Vessel Committee** issued an addendum to the then current 1956 Edition of the ASME Code, Section VIII for Unfired Pressure Vessels. This addendum made several important changes in the code rules and has since been incorporated in the 1959 Edition of Section VIII which was published in the summer of 1959.

The most sweeping of these changes is the new table of maximum allowable joint efficiencies, Table UW-12.

Under the 1956 Edition the vessel designer could choose among four basic vessel joint efficiencies for double butt welded construction:

80% — Spot Radiograph
85% — Stress Relieve
90% — Full Radiograph
95% — Full Radiograph and Stress Relieve

As now revised in the new Table UW-12 in the 1959 Edition, the choice has been narrowed to two basic vessel joint efficiencies:

85% — Spot Radiograph
100% — Full Radiograph

The elimination of stress relieving as an influence on joint efficiency was doubtless due to the fact that this operation, whatever other desirable effects it might have, leaves weld defects such as slag inclusion, incomplete penetration, etc., unrevealed and uncorrected.

This change in allowable joint efficiency is in line with the general trend of revisions made to the code since its inception in that as inspection techniques have become more reliable, greater refinement of design has been permitted with the nominal factor of safety gradually getting smaller. Joint efficiency has always been a kind of ignorance factor introduced into the design formula as a hedge against un-

TABLE 1. Weight per Linear Foot of Shell, lb.[1]

THK.➤ ID▼	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1	1 1/8	1 1/4	1 3/8	1 1/2	1 3/4	2	Weight Water
24	52	70	88	105	120	138	154	170	189	206	224	240	258	275	313	348	386	422	499	575	195
30	67	87	109	129	151	170	193	214	234	256	277	299	321	341	387	431	477	521	613	708	306
36	78	103	129	155	179	204	231	254	280	305	332	357	382	409	461	513	567	620	729	840	441
42	91	122	151	180	208	238	268	296	326	354	384	415	444	475	535	596	658	719	844	970	594
48	106	139	172	206	239	271	305	337	371	406	438	473	506	539	609	677	748	819	960	1104	782
54	119	157	194	231	268	303	343	379	419	454	492	531	567	605	684	762	838	917	1077	1235	983
60	132	173	215	257	299	338	380	422	463	504	546	589	630	672	758	843	929	1017	1191	1368	1221
66	146	190	237	282	327	371	418	460	509	554	600	647	693	738	831	926	1020	1117	1307	1498	147
72	157	209	257	307	356	407	456	504	554	605	653	707	754	803	905	1009	1112	1214	1422	1630	1758
78	172	226	278	333	386	439	495	545	600	653	708	761	816	869	980	1091	1201	1314	1538	1761	2063
84	185	244	301	358	416	471	532	587	644	704	761	820	879	936	1056	1173	1293	1412	1654	1894	2388
90	198	260	322	384	445	507	569	630	693	752	815	880	942	1003	1131	1258	1383	1512	1770	2028	2743
96	209	276	343	410	474	539	605	671	737	802	867	938	1004	1068	1204	1340	1473	1611	1885	2160	3118
102	225	292	366	436	502	574	644	710	782	851	922	995	1066	1134	1276	1420	1568	1710	2000	2293	3524
108	237	309	387	462	534	605	682	752	830	902	974	1053	1128	1200	1356	1504	1658	1809	2115	2426	3948
120	264	347	428	512	592	697	759	835	923	1000	1086	1170	1253	1334	1500	1670	1838	2008	2342	2690	4874

[1]Weights include an allowance of approximately 75 percent of manufacturer's standard permissible overweight tolerance and are based on a nominal steel density of 0.2833 lb per cubic inch.

TABLE 2. Weight of I.D. Elliptical Heads, lb.[1]
2:1 ratio, 2-in. straight flange

THK.➤ ID▼	5/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1	Wt. Water[2] Per Head
24	62	78	94	109	125	143	161	177	193	209	225	241	257		98
30	89	114	137	160	182	205	228	251	274	301	327	351	374		179
36	128	160	192	224	256	291	326	360	393	426	458	491	523		294
42		214	257	300	343	386	428	471	514	563	611	655	698		450
48			331	386	442	497	552	607	662	726	789	843	897		654
54			415	484	553	622	691	760	829	906	982	1052	1121		910
60			508	592	677	762	846	931	1015	1108	1200	1286	1371		1226
66			610	711	813	915	1017	1119	1220	1330	1440	1543	1646		1607
72				842	962	1083	1203	1323	1443	1573	1702	1824	1945		2059
78				983	1124	1265	1405	1545	1685	1836	1986	2128	2270		2589
84				1136	1298	1460	1622	1785	1947	2120	2293	2457	2620	2947	3203
90				1298	1484	1670	1855	2071	2286	2453	2620	2807	2994	3368	3908
96				1473	1683	1894	2104	2315	2525	2748	2970	3182	3394	3818	4707
102				1658	1894	2131	2368	2605	2842	3092	3341	3580	3819	4296	5609
108				1854	2119	2384	2648	2913	3178	3457	3735	4002	4268	4802	6619
120				2249	2571	2892	3213	3535	3856	4192	4528	4852	5175	5822	8989

[1]Weights include 100 percent of manufacturer's permissible overweight tolerance. Thicknesses are specified minimum thickness. Weights are based on actual gage which includes a thinning allowance for forming of 1/16 in. for minimum thicknesses of 15/16 in. and under, and 1/8 in. for minimum thickness of 1 in.
[2]Weight of water includes capacity of 2 in. straight flange section.

known defects that might possibly exist in the vessel seams. As the quality and reliability of the welding becomes more certain with the use of radiographic examination, the more we can approach the use of the full theoretical strength of the material in design.

Required Wall Thickness

Since joint efficiency is an integral part of the code formulae for calculating required vessel wall thickness, the increase in joint efficiency allowed for spot and full radiographing has the immediate effect of reducing the required thickness of vessels constructed in accordance with the 1959 Edition from 5 to 10 percent under the corresponding required thickness calculated in accordance with the 1956 Edition.

Fig. 1 is a graphic representation of the required shell thickness under the 1959 code for a range of diameters and design pressures and a group of the most commonly used steels. The chart is entered at the bottom left at the vessel design pressure, extended up to a line representing the grade of material and degree of weld inspection, followed from the intersection horizontally to a line representing the vessel inside diameter and from this intersection followed downward to the scale on the right indicating the minimum thickness required. This chart is approximate of course and is intended for rough estimates. For exact thicknesses the code formula should be used.

Corrosion Allowance

Since required thicknesses of vessels are from 5 to 10 percent thinner under the 1959 code, set amounts added to the required thicknesses as corrosion allowances become proportionately more important. If a thickness of 0.9 in. were required for pressure on a vessel designed in accordance with the 1956 code and 0.1 in. were added for corrosion, the corrosion allowance would represent 10 percent of the actual plate thickness of 1.0 in. For the same vessel designed under the 1959 code, the required thickness of which was 0.81 in., the same corrosion allowance would account for 12.3 percent of the actual plate thickness of 0.91 in. For this reason a higher percentage of vessel cost will be invested in corrosion allowance in the future.

Seamless Pipe vs Plate

Under the new joint efficiency table, rolled and welded plate should be more competitive with seamless pipe for use in small vessels of the size range 16 to 24 in. diameter. The use of plate for these sizes would also permit a little more flexibility in design in that a greater range of thicknesses and grades of material could be used. In addition the pipe manufacturer's permissible under-tolerance on wall thickness of 12½ percent would not have to be taken into account on rolled plate. The effect of this is that rolled, welded, and X-rayed steel plate could be of 12½ percent thinner wall thickness and still have the same maximum allowable working pressure as the corresponding seamless pipe.

Heads

Heads of seamless construction have not been affected by the joint efficiency revision, but heads fabricated from two or more pieces may now be constructed of materials somewhat thinner than heretofore provided the joining welds are radiographed.

Vessel Supports

Lighter vessels in the future will in some cases require heavier skirts and bases to resist wind and earthquake loads. (This is assuming that the weight of the vessel itself is considered in design as a factor resisting overturn.) Also additional thickness will be more frequently added to the vessel wall for this purpose.

With less vessel weight, foundation designs will also be affected. Tables 1 and 2 are prepared for convenience in rapidly estimating vessel weights once size and wall thickness

D. C. Enos, chief engineer for Trinity Steel Company, Inc., Dallas, since 1957, is well equipped to write on pressure vessel design from the fabricator's point of view. Formerly chief engineer for refinery fabrication for Dallas Tank Company, his experience includes service as a vessel designer for The Fluor Corporation, Ltd., Los Angeles, and as chief engineer for Industrial Manufacturing Company, Sweetwater, Texas. Enos, a native Dallasite, attended Southern Methodist University and the University of Texas. He is a member of the American Welding Society.

have been determined. Additional weight due to vessel attachments must be added.

Manholes and Nozzles

Probably the main effect of the 1959 code upon vessel openings is in the required reinforcement of these openings. The smaller the amount of excess thickness in the vessel wall over what is required for pressure (based on a seamless vessel, assuming the opening is in solid plate), the more material must be put back in the form of reinforcing pads. Since a fully radiographed vessel will now be designed as if it were of seamless construction there will be no excess thickness available and openings in such a vessel must be reinforced more heavily than in the past.

Stress Relieving

The elimination of stress relieving as a joint efficiency factor means that this operation will be less frequently employed because a great lot of the stress relieving which has been done in the past has been specified for the sole reason of reducing the required minimum thickness of the vessel. Stress relieving has not been completely deleted however. It is still mandatory for some grades of material, thicknesses, etc., as in the past.

Fabrication Cost

The general effect of the code revision has been a reduction in vessel cost. Average fabrication cost has probably dropped at least 5 percent, perhaps more.* The exact amount of this reduction is difficult to set down in concrete figures because of many secondary factors, such as cheaper transportation of raw material to the fabricator, smaller amount of welding wire, cheaper transportation of finished vessel to the job site, reduction in erection expense, etc. To offset these savings, to some extent at least, is the higher cost of those vessels built under Column "C" of Table UW-12; i.e., with a joint efficiency of 70 percent for double butt welded seams, even though some of these vessels have their wall thicknesses selected for reasons other than internal pressure load and are not affected by the change in allowable joint efficiency.

Welding Quality

Perhaps the most important result of this change in allowable joint efficiency is the effect this change should have in improving the quality of welding generally. The low allowable joint efficiency of 70 percent which must be used in designing vessels when no radiographing is to be performed, results in a plate thickness (and therefore plate cost) considerably greater than that required when the seams are to be spot radiographed or fully radiographed. This fact is acting as an economic spur among fabricators who sell a standard line of products of their own design since they can reduce their material costs by raising the quality of their welding. Many small shops have built vessels for years with no quality control check on the welding reliability except for ordinary visual inspection of the outside of the welds. These fabricators are now being forced for economic reasons to employ radiographing and much sub-standard welding should be eliminated.

Also in industries where pressure vessels are used for transportation purposes, as in the hauling of propane, anhydrous ammonia, and similar products, the change in joint efficiency factors practically insures that the great majority of new vessels built will have all seams fully radiographed since the weight savings pays for this expense many times over. Inasmuch as mobile pressure vessels, particularly those hauling products that are either inflammable or explosive, are in a service that is about as critical as any from a safety standpoint this particular result of the code change is a very desirable one.

Inspection Standards

With vessels now being constructed of lighter materials than they would have been in the past for the same design conditions, the competence of the code inspector becomes more important than ever. Considerable variance exists in inspection standards between different code inspectors and the present highly competitive condition of the vessel fabrication industry tends to spotlight this difference. If one fabricator receives only cursory code inspection of his work and takes advantage of this situation by cutting corners (for example, by not removing excess weld reinforcement) he is able to reduce his labor costs and consequently under-bid his competitors. The vessel market being what it is today this disparity of inspection standards is causing some bitterness in the industry and needs looking into.

As this article is being written the National Board of Boiler and Pressure Vessel Inspectors is meeting in Denver and inspection standards is one of the items on the agenda. Possibly some method will be found to see that all code stamped vessels receive a reasonably competent inspection that is equally stringent for all fabricators. One proposal, which seems very pertinent, is that the duty of checking design be removed from the code inspector's responsibilities and placed elsewhere, perhaps with a newly created group of registered Vessel Designers. The situation seems to be that while the level of inspection competence is not improving (and some say getting poorer) the ASME Code gets more complicated every year and is beginning to resemble something off the shelf of a lawyer's library. If the code inspector were confined to the task of checking materials and workmanship only, a formidable enough job in itself these days, it is reasoned that a standardized minimum level of quality could be more easily maintained. Also, fewer and fewer code inspectors are taking the time to check vessel designs anyway, leaving this responsibility unexercised. ★ ★ ★

*A discussion of fabrication economics under the 1959 ASME Section VIII Code will be presented by the author in this magazine in the near future.

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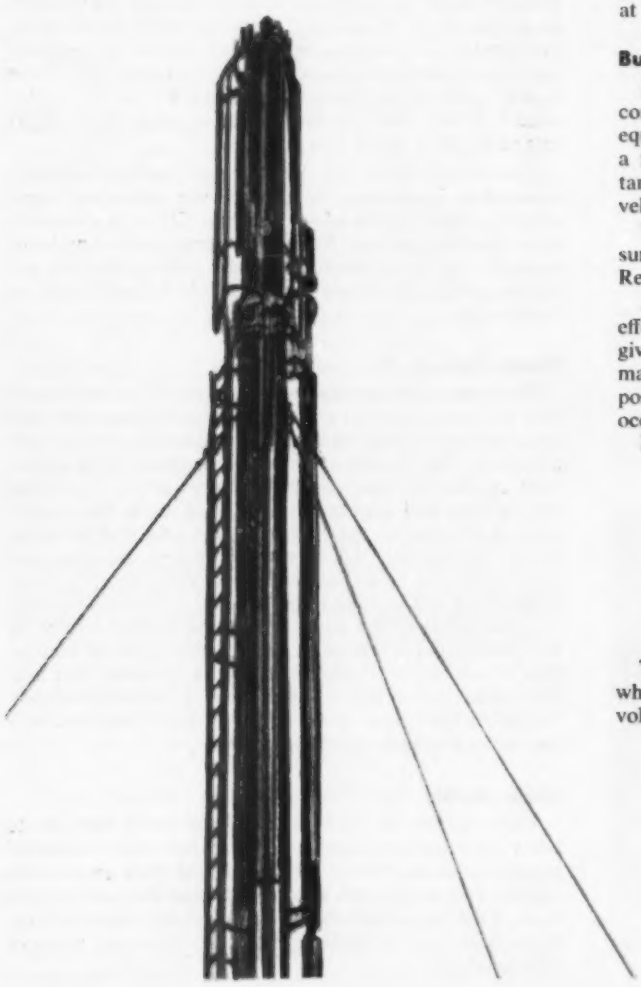

MANY RECENTLY developed chemical processes require intermittent venting of pure vapors and oxygen-enriched mixtures. When recovery of these streams is hazardous or uneconomical, the usual means of disposal is by burning in a flare to prevent accumulation of explosive mixtures in the area.

All pure combustible fuels or a mixture of them will burn when vented to free air and ignited unless they contain inerts in excess of a critical concentration. Air or oxygen-enriched combustible fuel mixtures will burn on ignition in free air provided the fuel concentration is above the lower limit of inflammability.

All flare stacks burning combustible mixtures have a stable operating velocity range above and below which they will not operate safely. At all stack velocities below the lower velocity limit all or part of the flame will drop down into the stack resulting in an explosion or an explosion followed by a detonation. Above the upper velocity limit the flame will leave the port and in the absence of pilots could be blown out by strong air currents. Proper location of pilots will permit the flame to burn at velocities in excess of the blowoff rate. Fig. 1 is a typical stability diagram for air or oxygen-enriched combustible fuel mixtures. This diagram shows the effect of percent fuel X on the stability of a fuel X-air feed mixture at a constant feed temperature for a given stack.

Burning Velocity, U_B

For a flame to remain stationary in space the rate of consumption of unburned combustible mixture must be equal to the feed rate of the mixture. The velocity at which a flame burns into the gas in the direction normal to a tangent to the flame surface at any point is the burning velocity.

Burning velocity is constant at a given temperature, pressure, and mixture concentration and is independent of Reynolds number.

A typical curve for the ethylene-air system showing the effect of ethylene concentration on burning velocity at a given temperature and pressure is presented in Fig. 2. The maximum burning velocity is near the stoichiometric composition for complete combustion and minimum values occur at the limits of inflammability.

Five basic methods are used to measure burning velocity:

1. Bunsen burner[5]
2. Flat flame
3. Soap bubble
4. Cylindrical tube
5. Spherical bomb

The Bunsen burner is based on a photograph of the flame which shows the shape of the conical burning surface. The volumetric rate of flow divided by the surface area of the

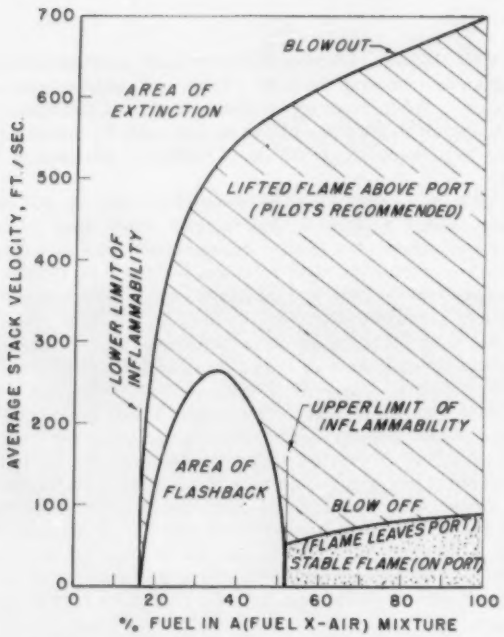

FIG. 1. Flare stack stability typical diagram for a hypothetical fuel X - air mixture. Basis: for a given stack size and feed temperature.

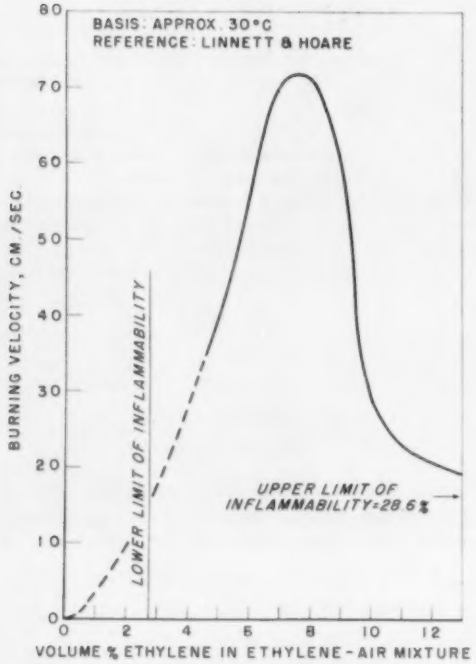

FIG. 2. Typical burning velocity curve for ethylene air system.

cone is equal to the burning velocity. This measurement uses a stationary flame.

The flat flame method is similar and is applicable to mixtures having low burning velocities; e.g., lean hydrocarbon-air mixtures with burning velocities below 15 cm per sec.

In the **soap bubble method** the mixture is contained in a soap bubble and ignited at the center by a spark so that a spherical flame burns radially through the gas. Pressure remains constant because of the expansion of the soap film. The flame movement divided by the expansion ratio on burning is the burning velocity. A rotating drum camera is used to record the operation. This method is used only for high burning velocity measurements and is probably the most accurate.

Use of the **cylindrical tube method** is also restricted to fast burning velocities and is normally used for the measurement of maximum burning velocities for any given system.

It is recommended that for any laboratory determinations the flat flame method be used for low burning velocities (lean and rich mixtures) and the soap bubble method for high burning velocities.

Water vapor has been found to have the same effect on burning velocity as nitrogen for the propane-air system at 323°K. This was calculated from data shown in Fig. 3 attached. Curve A shows the decrease in system maximum burning velocity due to water vapor. Data gave a perfectly straight line and was extrapolated to find the percent water vapor in the system necessary to extinguish the flame. Curve B shows the effect of nitrogen concentration on the propane-air system at 311°K and 422°K and shows the flame will be extinguished when nitrogen dilution reaches an oxygen/oxygen and nitrogen ratio of 0.15. At extinction (for Curve A data) calculations show the oxygen per $O_2 + N_2 + H_2O$ ratio is 0.167. This is a close check showing $(N_2 + H_2O)$ acts as if $(N_2 + H_2O)$ was all (N_2).

Carbon monoxide $CO + O_2$ system however shows a tremendous increase in burning velocity with water vapor addition. The absence of hydrogen in CO as is present in other hydrocarbon and hydrogen systems studied probably accounts for this. Carbon monoxide, carbon disulfide, and nitrous oxide all deviate from published correlations on combustion.

Flame Speed, S_f

For combustible systems, several investigators have shown that in a tube closed at one end and ignited from the open end, the flame travels through the combustible mixture with a uniform velocity over a part of the tube length. The magnitude of this uniform velocity for any fuel at a constant temperature and pressure is dependent upon the fuel-air ratio of the mixture, the diameter of the tube, and the direction of propagation, that is, whether upward, downward, or horizontal. This uniform linear rate of flame travel is called flame speed and is equal to the product of burning velocity, U_B, multiplied by the area of the flame surface divided by the cross sectional area of the tube. Flame speed for laminar flow is constant at a given temperature, pressure, and mixture concentration and is independent of Reynolds number. Turbulent flow flame speed differs in that it increases with increasing Reynolds numbers.[10]

Flash Back

Flash back is the flashing of a flame into a tube due to low tube velocities. Any combustible fuel-oxygen-enriched mixture with or without inerts will flash back into a tube against the flow of gases at or below some low tube velocity limit, if the fuel concentration of the mixture into which the flame is burning is between the lower and upper limits of inflammability.

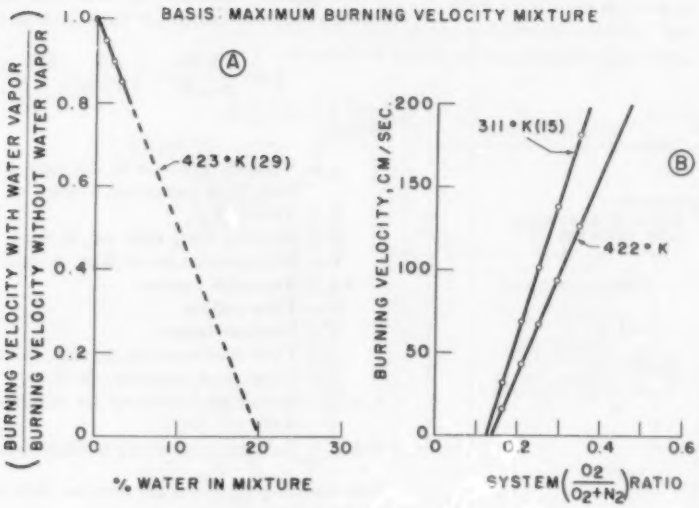

FIG. 3. Effect of water vapor on propane - air system.

A typical flash back curve is shown in Fig. 1 (lower curve). Maximum flash back velocity always occurs between the limits of inflammability and usually for 90 percent to 130 percent of stoichiometric concentration for complete combustion. Minimum flash back velocities occur at the limits of inflammability.

All combustible fuel mixtures that are capable of supporting a flame on a flare stack will have some velocity below which they will flash back into the stack. The one exception is a very small critical diameter below which flash back cannot occur. Methane-air mixtures, for example, will not propogate flame through a tube having an inside diameter less than 0.142 in. This diameter varies with the fuel concentration, pressure, and temperature for any given mixture.

Flash back into a tube, if allowed to continue for a given distance which varies for all systems, **can lead to detonation and disaster.** [6,7,10]

Average gas tube velocity at which flash back occurs is exactly equal to the flash back velocity, U_F, but is always greater than the burning velocity, U_B, of the flowing combustible mixture. The latter is true because the flame initially flashes back into the lower velocity gas near the tube wall.

To help explain what happens, consider a laminar jet of explosive gases issuing from a tube into the atmosphere. For laminar flow, for example, the gas velocity at the tube wall is zero and increases to a maximum at the center in a parabolic cross sectional profile. Near the wall the line of flow rate change (velocity gradient) with respect to the wall can for a short distance be assumed linear. The temperature of the unburned gas near the wall is the lowest due to radiation and convection loss.

At some low rate of flow of unburned gas, the flame will begin to enter the tube near the wall where there is a critical thickness of gas through which a flame will not flash back called the quenching distance. This is one-half the diameter of a tube below which the explosive mixture will not flash back. At this exact circular locus of points, the gas velocity is equal to the burning velocity but much lower than the average tube velocity. If the average velocity in the tube is

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E. E. LUDWIG J. D. HAJEK

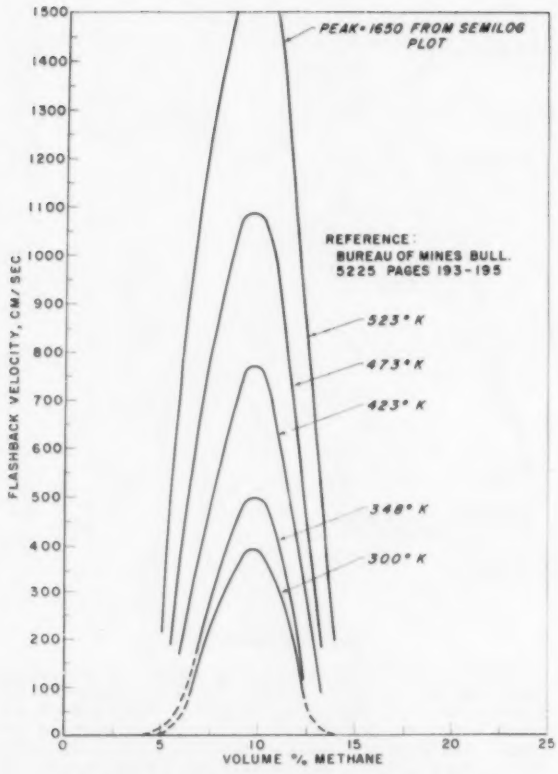

FIG. 4. Effect of temperature on flashback methane-air system.

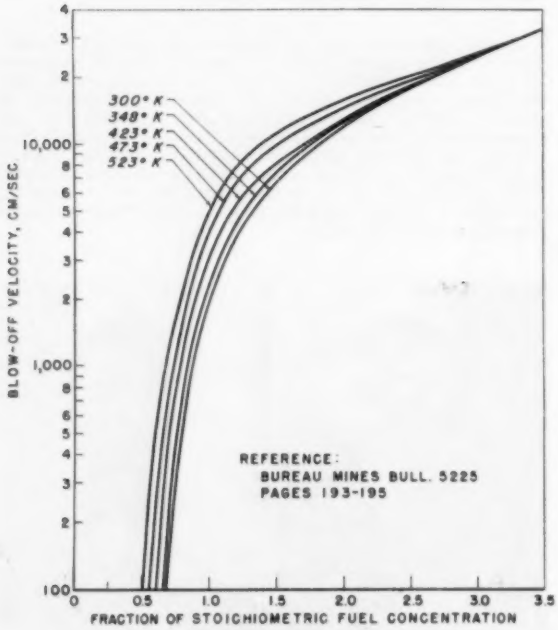

FIG. 5. Effect of temperature on blow-off methane-air system.

decreased below this critical velocity, the flame will flash back into the tube at the rate the velocity decreases at the quenching distance.

Lewis and von Elbe developed a basic equation based on theoretical considerations for flash back as follows:

$$g = \frac{\lambda V Re}{16 \pi R^3} = \frac{\lambda V}{16 \pi R^3}\left(\frac{DU_F \rho}{\mu}\right)$$

Where:

- g = Velocity gradient at the tube wall below which flash back can occur, 1/sec.
- D = Tube ID, ft
- U = Velocity (avg tube vel, ft/sec)
- V = Volumetric rate of flow, ft³/sec
- Re = Reynolds number
- R = Tube radius
- λ = Friction factor
- ρ = Tube feed mixture density, lb/ft³
- μ = Tube feed viscosity, lb/ft-sec
- L & T = Subscripts referring to laminar and turbulent flow
- F & B = Subscripts referring to flash back and blowoff

The resulting equation for *laminar* flow was found to be valid as follows:

$$(g_F)_L = \frac{8\,(U_F)_L}{D} \text{ and } (U_F)_L = \frac{(g_F)_L D}{8}$$

For laminar flow ($Re < 2100$) $\lambda = \frac{64}{Re}$

For turbulent flow (for Re 5000 to 200,000) $\lambda = \frac{0.316}{(Re)^{1/4}}$

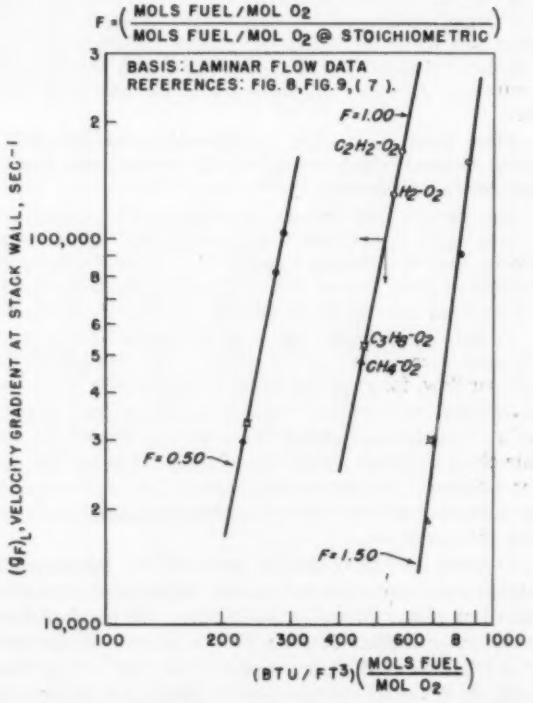

FIG. 6. Flash back correlation for pure fuels and mixtures of oxygen.

Steam-Hydrocarbon for H_2 Production

Licensed by: Girdler Construction Division, Chemetron Corporation

DESCRIPTION: This process for production of hydrogen from natural gas or other feed stocks such as refinery gas, propane, and butane, is well suited to the recent refinery trend toward separate hydrogen-producing plants for feedstock preparation and product upgrading. A refinery stream can normally be utilized as feedstock and by operating the steam-hydrocarbon process at elevated pressure, advantage can be taken of the available pressure of the feedstock to save in subsequent hydrogen compression costs.

If the feedstock stream contains sulfur compounds, which would temporarily deactivate the nickel catalyst used in the hydrogen plant, they can usually be removed by caustic wash and/or activated carbon preceding the steam-hydrocarbon reaction. In some cases, however, more extensive treatment is required.

The hydrocarbon stream is reacted with steam at elevated temperatures (1500 F and higher) over a nickel catalyst, converting the hydrocarbons almost completely to hydrogen, carbon monoxide, and carbon dioxide. Since the reactions are endothermic, heat must be supplied, so the catalyst is placed in alloy tubes installed in a furnace.

The gases leave the furnace at about 1500 F and pass to a converter where carbon monoxide is reacted with steam to form carbon dioxide and hydrogen. Carbon dioxide removal is accomplished by the Girbotol process, which uses an aqueous solution of monoethanolamine to absorb the carbon dioxide. Residual carbon oxides are converted to methane by reacting with hydrogen at elevated temperatures over a nickel catalyst.

The Girdler hydrogen process described above is used for the production of the 90 to 98 percent purity hydrogen normally required for refinery use. By addition of more purification stages, higher purity (99.7+ percent) hydrogen, can be produced. Thus it is possible to vary operating economics to suit the purity requirements of each installation.

YIELDS:

Feedstock and utility requirements vary considerably, but the following are considered typical for production of 1000 standard cu ft of 98 percent hydrogen:

Natural gas, 175 psig	265 std cu ft
Fuel gas	275 M Btu (NHV)
Electric power	1.5 kwhr
Cooling water, 75F, 30F rise	600 gal
Steam, 70 psig	100 lb
Catalyst & chemical costs	2¢

OPERATING PERSONNEL:

Plant operation is virtually automatic. Operating labor requirements for a 10,000,000 cu ft per day plant amount to one to two men per shift.

INVESTMENT:

By tailoring the plant to the capacity and purity requirements of the refiner it is possible to produce hydrocarbon at a direct cost of 15¢ to 20¢ per Mcf and a total cost, including fixed charges, of 25¢ to 35¢ per Mcf. Costs vary considerably with quantity and quality of product gas and locality and customer specifications. A typical 10,000,000 cu ft per day plant producing 90 to 98 percent pure hydrogen will cost approximately $2,000,000. This type of plant includes a waste heat boiler to supply all the steam required for hydrogen production.

Girbotol Gas Purification Process

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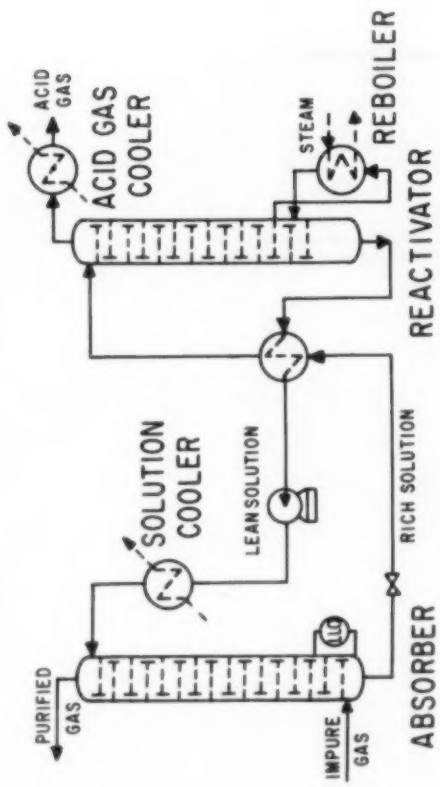


OPERATING CONDITIONS: Plants are customarily designed to purify gases at their full line pressure, and pressure drop through the equipment ordinarily will not exceed 5 to 10 lb per sq in.

Girbotol Gas Purification Process

Licensed by: Girdler Construction Division, Chemetron Corporation

DESCRIPTION: This ethanolamine absorption process is used extensively for removal of hydrogen sulfide from natural gas, refinery gas streams, and liquid streams of lighter hydrocarbons such as propane, and for separation of carbon dioxide from hydrogen and synthesis gases.

The Girbotol process is based on the reactions of acid gases, hydrogen sulfide, and carbon dioxide, with ethanolamines that are organic bases. Absorption temperature is generally 80 to 120F and pressures ranging from atmospheric to well over 1000 psig have been employed. Subsequently, raising the temperature of the amine solution to its boiling point causes the reaction to be reversed and the acid gas is expelled.

An aqueous solution of monoethanolamine is commonly used for most complete removal of hydrogen sulfide and carbon dioxide. Diethanolamine is desirable, however, in purifying refinery gas containing carbonyl sulfide, which will react with monoethanolamine to form a urea derivative that is not broken down in the reactivator. Triethanolamine is used in some cases where both carbon dioxide and hydrogen sulfide are present and it is desired to remove the hydrogen sulfide but not the carbon dioxide. A degree of selectivity in this respect can be attained by proper choice of operating conditions.

A Girbotol plant consists basically of an absorber, where the acid gas is removed from the process gas by an aqueous solution that is 15 to 30 percent by weight of amine, and a reactivator in which hydrogen sulfide and/or carbon dioxide are stripped from the rich solution by heat to pass out of the tower as a concentrated gas, while the lean amine solution is recycled to the absorber in a continuous process. Heat exchangers are used to make the process more economical.

For removing hydrogen sulfide from propane, butane, natural gasoline, and other liquid hydrocarbons, a packed or sieve plate tower is used for the absorber and slight additional instrumentation is required.

YIELD:

The Girbotol process readily reduces the hydrogen sulfide content of gas to less than 5 grains per 100 cu ft, resulting in acceptable purity for pipeline transportation and for refining operations in the case of refinery gases and liquid hydrocarbons where sulfur content would poison expensive catalysts.

Performance data for typical Girbotol plant installations follows:

NATURAL GAS PURIFICATION

Gas Flow	30,000,000 std cu ft per day
Gas Pressure	300 psig
Hydrogen Sulfide Content:	
Inlet Gas	34 percent (vol.)
Outlet Gas	Neg. to Lead Acetate

LIQUID HYDROCARBON PURIFICATION

Hydrocarbon Flow	132 gal per min
Sp gr Hydrocarbon Feed	0.533
Hydrogen Sulfide Content per 100 std cu ft equivalent gas:	
Inlet hydrocarbons	1,890 grains
Outlet hydrocarbons	5 grains

OPERATING PERSONNEL:

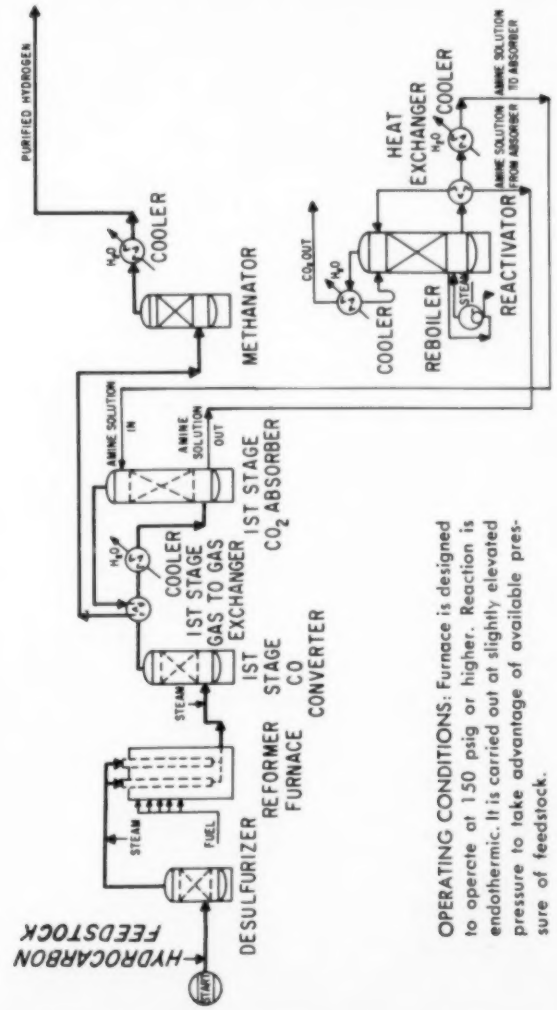
The process is largely automatic and except in the very largest installations requires the services of only one man part time.

ECONOMICS:

Plant investment and operating costs vary considerably with volume and composition of gas treated, desired purity, site conditions and type of plant. Treating costs for desulfurizing natural gas have been known to range from 3 mills to 2 cents per Mcf, but these are not necessarily the extremes. Net cost can be substantially reduced in many cases by installing companion sulfur recovery facilities to convert the hydrogen sulfide to elemental sulfur, at the same time eliminating a potential air pollution problem.

Steam-Hydrocarbon for H_2 Production

Licensed by: Girdler Construction Division, Chemetron Corporation



OPERATING CONDITIONS: Furnace is designed to operate at 150 psig or higher. Reaction is endothermic. It is carried out at slightly elevated pressure to take advantage of available pressure of feedstock.

The resulting equation for **turbulent** flow was not found to be valid when **laminar** velocity gradient data are used.

Actual experience in our plant and in furnace tubes shows the above equation gives flash back velocities which are much too low and on the dangerous side.

An inspection of the literature[10,16] shows that only two sets of data on turbulent flow are available as compared to considerable data on laminar flow.

Two investigators[10] report the turbulent conditions may be equal to the product of the laminar condition value times the square root of some turbulent exchange coefficient which could not be tied down to practical terms.

The following equation recommended for **turbulent** flow was developed for use with **laminar velocity gradients:**

Turbulent flash back velocity was assumed to be equal to a maximum possible laminar velocity at a Reynolds number of 2100.

$$\text{Since } U_L = \frac{(g_L)\ (D)}{8}$$

$$\text{and } Re_L = 2100 = DU_L\left(\frac{\rho}{\mu}\right)$$

$$\text{Then } 2100 = \left(\frac{8\,U_L}{g_L}\right)(U_L)\left(\frac{\rho}{\mu}\right)$$

Assuming $(U_F)_T = (U_F)_L$ max., the following equation results:

$$(U_F)_T = \frac{16.20\ (g_L)^{0.5}}{\left(\frac{\rho}{\mu}\right)^{0.5}} \text{(uncorrected)}$$

Actual data was higher than the above equation predicted by a value of 1.6.

The ratio of calculated to actual velocity was plotted as the ordinate on log-log paper against the turbulent Reynolds number based on actual velocity. A slope of + 0.5 was obtained for a straight line which gave a velocity ratio of 1.0 at a Reynolds number of 1300. The equation of the curve is:

$$0.02773\ (D)^{0.5}\ (U_F)_T{}^{0.5}\left(\frac{\rho}{\mu}\right)^{0.5} = \text{correction factor}$$

The product of this factor and the uncorrected equation gives the following equation **recommended for turbulent flash back** using laminar g_F data :

$$(U_F)_T = 0.2015\ (g_L)\ (D)$$

Values of $(g_F)_L$ for a large number of systems are presented in Bureau of Mines publication 5225.[6] Data for other systems are presented in the *Third, Fourth, and Sixth Symposium on Combustion*, published by the Williams and Wilkins Company of Baltimore, Maryland. Data for the hydrogen-air, hydrogen-oxygen, and acetylene-oxygen systems are presented in Fig. 7, 8, and 9 respectively. Other data is in the literature. This system is expected to work for air and oxygen systems and should, therefore, apply for systems containing oxygen concentrations in $(N_2 + O_2)$ from 21 to 100 percent.

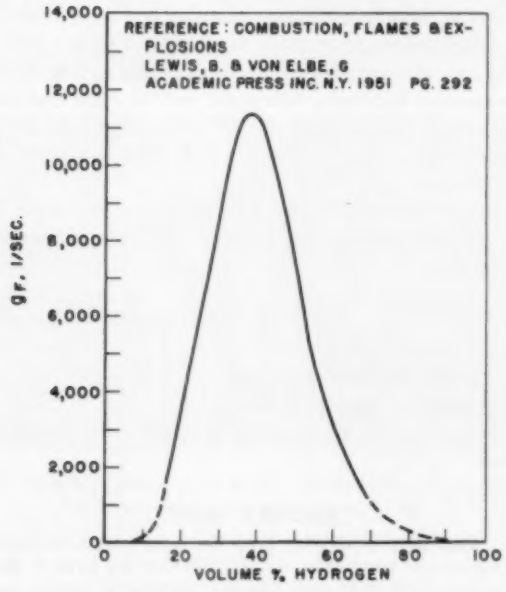


FIG. 7. Flashback hydrogen - air system.

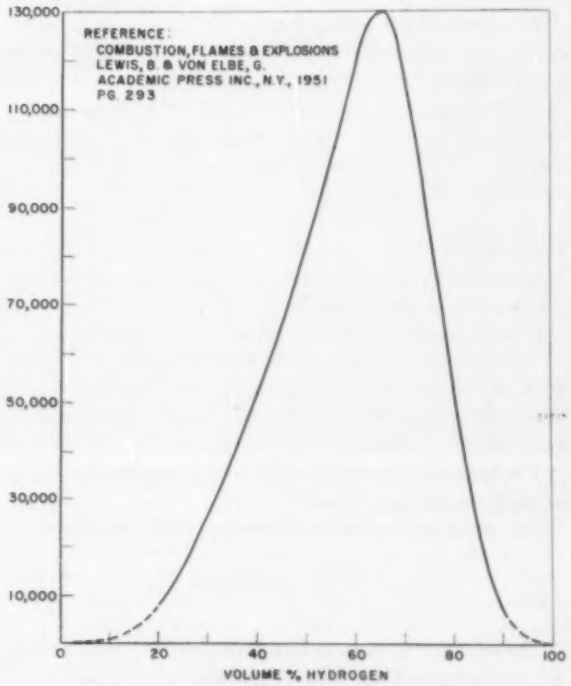


FIG. 8. Flashback hydrogen - oxygen system.

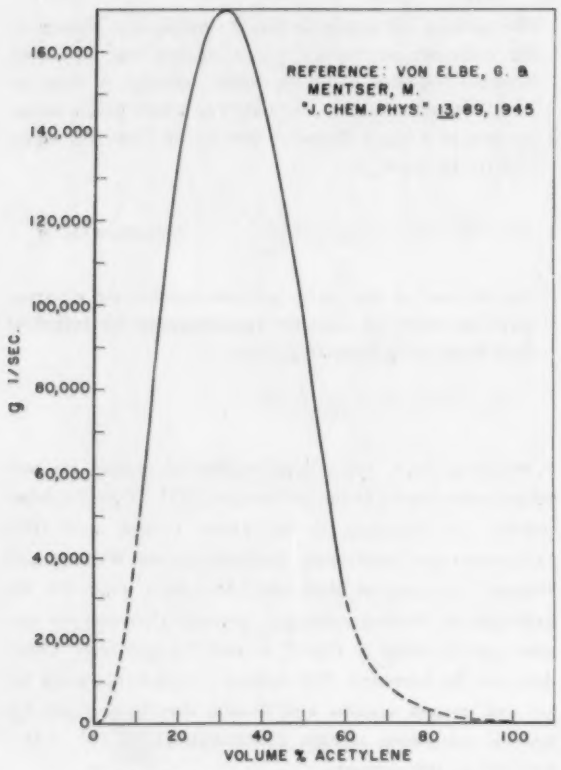


FIG. 9. Flashback acetylene-oxygen system.

Temperature has a larger effect on flash back velocity than it has on burning velocity. Fig. 4 shows the effect of temperature for a methane-air system. Only one other set of data (propane-air system) is available. It is postulated that a correlation including the Prandtl number and density may resolve the data for general use. Minimum ignition temperature may also be needed.

Blowoff

Blowoff is simply the lifting of a flame above the port at a Reynolds number above 2100.

Blowoff usually occurs at relatively low velocities such as 20-25 ft per sec, for example, for the butane-air system. The hydrogen-air system, however, is an exception as it has a much higher blowoff velocity range. Oxygen systems always have a higher blowoff velocity than air systems.

The basic equation used in flash back derivation was found to apply for laminar blowoff.[17]

The equation for **laminar** blowoff is valid as follows:

$$(g_B)_L = \frac{8\,U_B}{D} \text{ and } U_B = (g_B)_L$$

The equation applied to **turbulent** flow was found not to be valid when **laminar** velocity gradient data are used.

Data in the literature[17] for the hydrogen-air system show that blowoff velocity for turbulent flow is independent of diameter.

In order to extend this data to other systems, two independent derivations were made and found to check.

The ratio of turbulent velocity (from g_L) over laminar velocity (from g_T) was plotted as the ordinate on log-log paper against the laminar Reynolds number based on g_L and diameters from turbulent data. A slope of −0.50 was obtained for a straight line which gave a velocity ratio of 1.0 at a Reynolds number of 2050.

By combining

$$(U_B)_L = \frac{(g_L)^D}{8} \text{ and } (Re)_L = D\,(U_B)_L\left(\frac{\rho}{\mu}\right) \text{ into}$$

the equation for a straight line $(U_B)_T = 45.28\,(U_B)_L\,Re^{-0.5}$ the following equation results:

$$(U_B)_T = \frac{(16.01)\quad (g_L)^{0.5}}{\left(\frac{\rho}{\mu}\right)^{0.5}}$$

The second approach assumes turbulent blowoff velocity is equal to a maximum possible laminar velocity at a Reynolds number of 2100.

The resulting equation is

$$(U_B)_T = \frac{16.20\quad (g_L)^{0.5}}{\left(\frac{\rho}{\mu}\right)^{0.5}}$$

as developed in the flash back section.

The above equation is recommended for use with laminar $(g_B)_L$ data for determining turbulent blowoff velocities.

Values of $(g_B)_L$ for a large number of systems are presented in Bureau of Mines publication 5225.[6] Data for other systems are presented in the *Third* and *Fourth Symposiums on Combustion* published by the Williams and Wilkins Company of Baltimore, Maryland, and the *Fifth* and *Sixth Symposiums on Combustion* published by the Reinhold Publishing Corporation of New York, N. Y. Other data is in the literature.

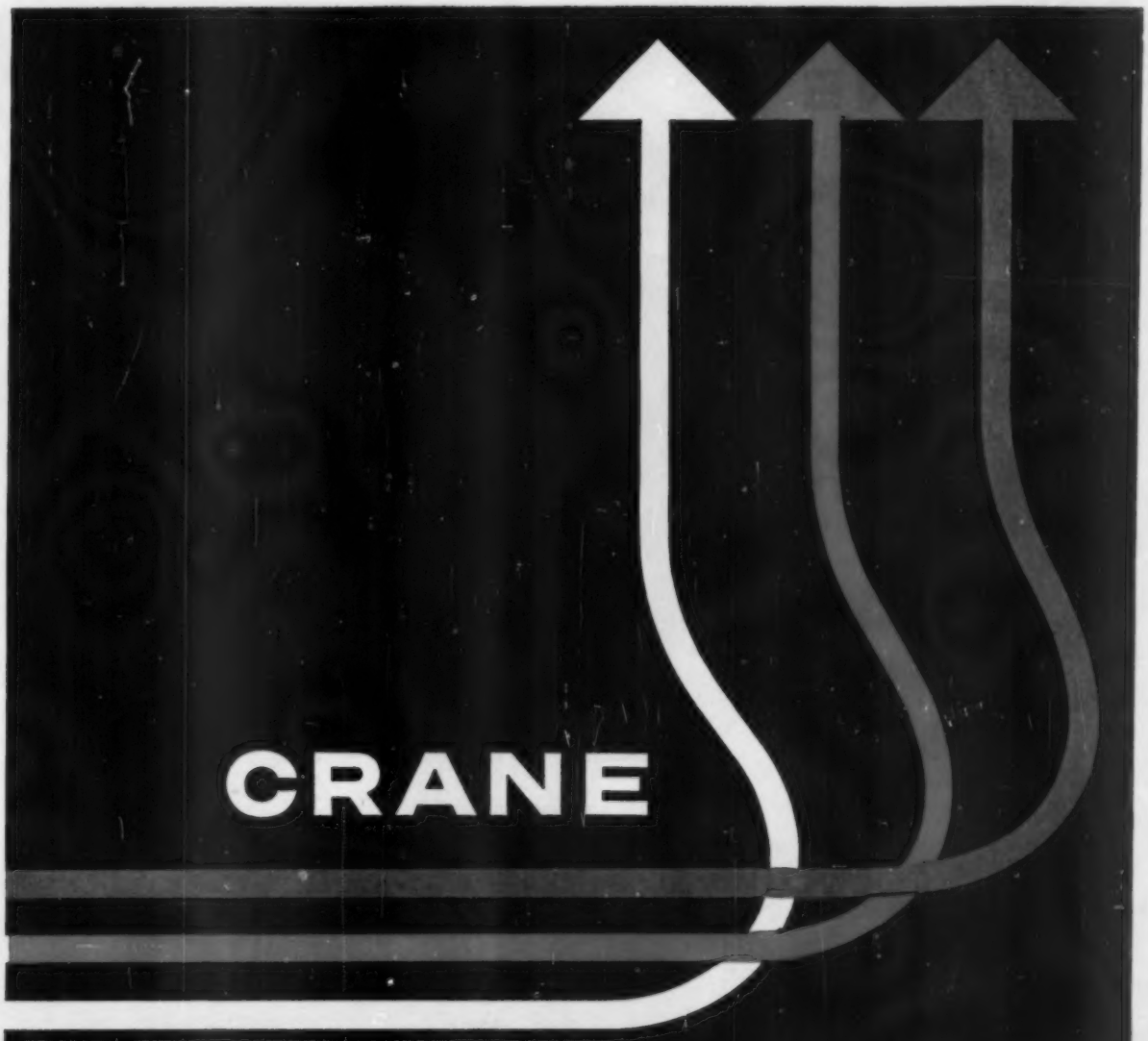
Temperature apparently has an appreciable effect on blowoff for methane-air mixtures between inflammable limits with a progressive decreasing effect above the upper limit as can be seen by an inspection of Fig. 5 for the methane-air system. Only one other set of data (propane-air system) is available.

A correlation similar to that shown in Fig. 6 for flash back may also apply to blowoff.

A number of other useful articles have been published.[2,7,15,16,17]

EDITOR'S NOTE

You have read Part 1 of the most comprehensive report we have seen on this subject. In Part 2 the authors will deal with Blowout, Limits of Inflammability and Heat Damage from Flame Radiation. They will also present a detailed numerical example showing all process calculation steps involved. Look for Part 2 in an early issue of PETRO/CHEM ENGINEER and add it to your files.



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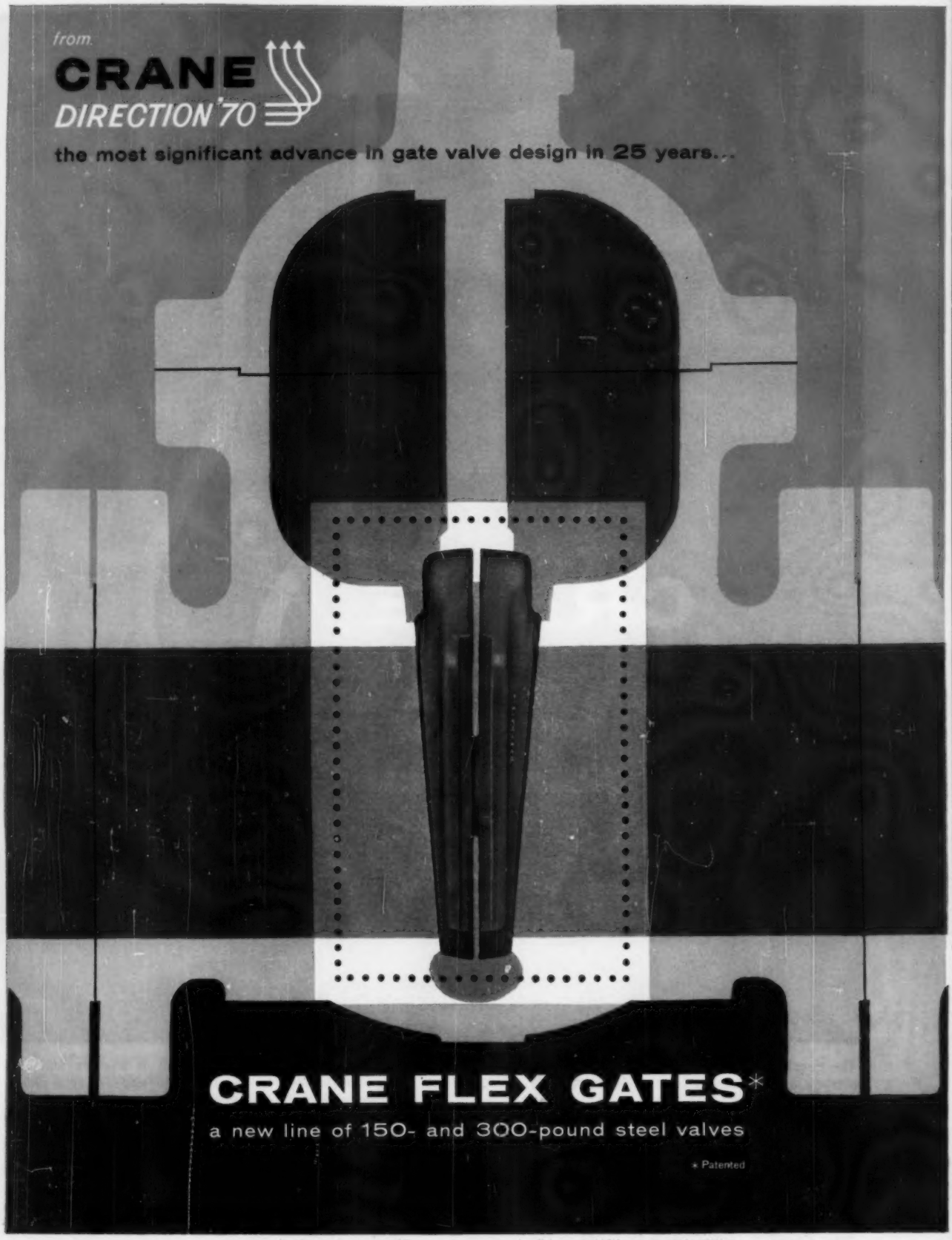

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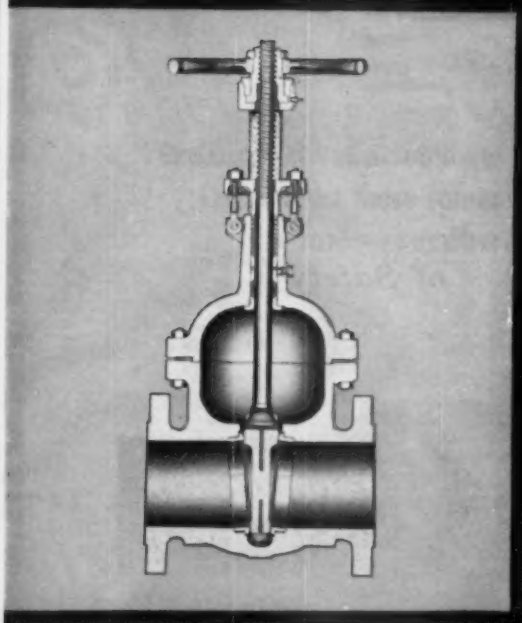

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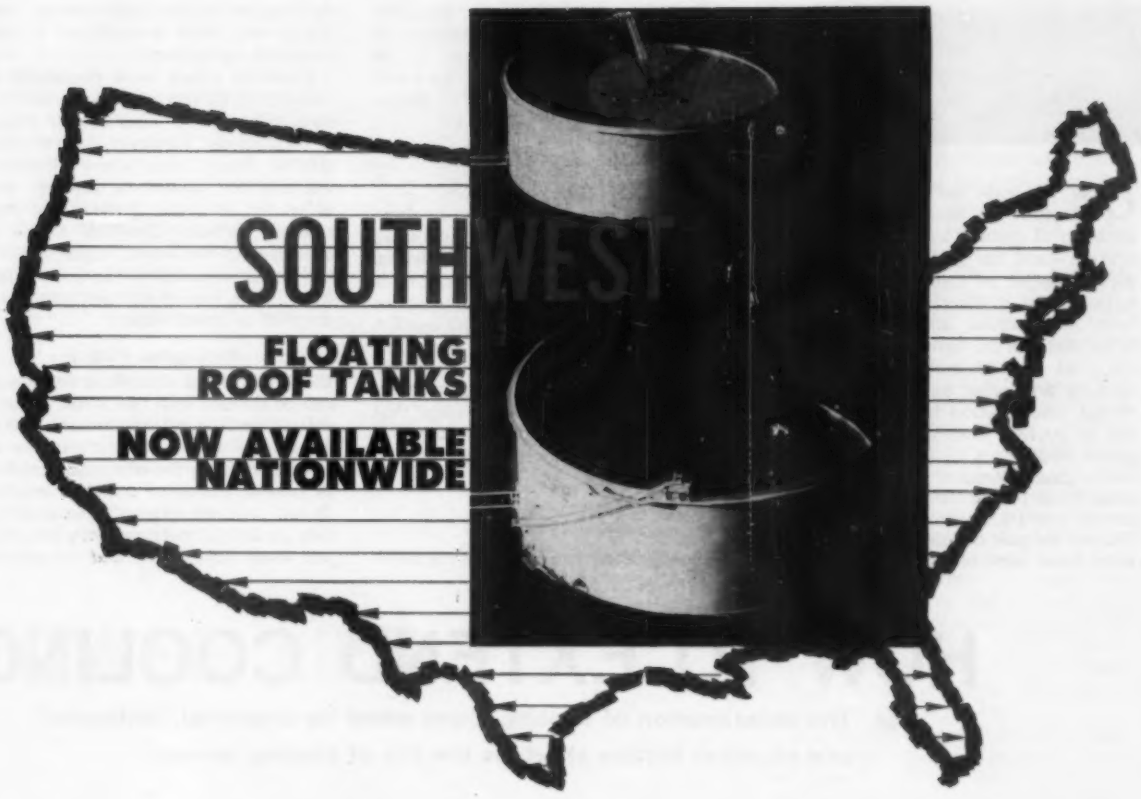

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HELPFUL WATER CONDITIONING DATA FROM BETZ

HOW TO EXTEND COOLING

■ The deterioration of cooling tower wood by chemical, biological and physical factors shortens the life of cooling towers.

OVER THE PAST DECADE considerable attention has been focused on the problem of cooling tower wood deterioration—and for good reasons. Complete collapse of some cooling towers has occurred. In other cases, fan supports have deteriorated, and the fans have fallen through the tower. Accidents have occurred due to collapse of ladders, decking and other parts of the tower. Wood deterioration has shortened the life of cooling towers from the anticipated 20-25 years to 10 years or less in many cases. Repairs and replacement costs have been excessive, and cooling tower operation has been inefficient. During the past decade, many organizations have been engaged in a study of the problem to determine the causes and possible cures. Since water is an intimate part of the problem, Betz Laboratories is actively engaged in the study of wood deterioration.

Cooling Tower Wood Composition

Redwood is the most commonly used material for cooling tower construction. It has been in use for this purpose almost since the advent of cooling towers themselves. Originally, this material was selected because of high strength to weight ratio, ready availability, ease of fabrication, cost and natural resistance to decay. Other species are used for this purpose, particularly Douglas Fir and less frequently cypress and pine.

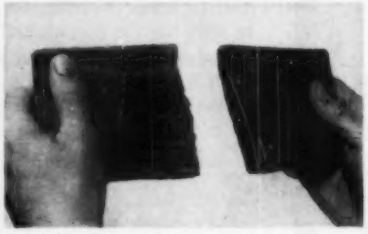
Wood is composed of three main components; celiulose, lignin and natural extractives. The cellulose exists as long fibers almost identical to cotton fibers, and gives wood its strength. The lignin acts as the cementing agent for the cellulose. The extractives contain most of the natural compounds which contribute to the resistance to decay. In general, the more highly colored woods are the more durable. A typical analysis of redwood, based on the dry weight, will show approximately 50% cellulose and hemi-cellulose, 30% lignin and 20% extractives. The extractives present in redwood make this material one of the most resistant to decay. Unfortunately, the extractives present in all woods are largely water soluble, and will be leached from the wood by the circulating water. The strength of the lumber does not appear to be affected by leaching. However, the wood does become more susceptible to decay.

Types of Wood Deterioration

Cooling tower wood is subject to three main types of deterioration; chemical, biological, and physical. It is rare where one of these types of deterioration is present without the other. In most cases these different types of deterioration occur simultaneously. When deterioration occurs it is difficult to determine which type of attack is predominately responsible. However, it is evident that physical and chemical deterioration will render the wood more susceptible to biological attack.

Chemical Attack

Chemical deterioration of cooling tower wood commonly is manifested in the form of delignification. Since the lignin component of the wood is affected and removed by this type attack, the resultant residue is rich in cellulose. The chemicals most commonly responsible are oxidizing agents such as chlorine, and alkaline materials such as sodium bicarbonate and sodium carbonate. *The attack is particularly severe when the combination of high chlorine residuals and high alkalinity concentrations are maintained simultaneously.*



Brash, checked wood.

Typically the wood takes on a white or bleached appearance, and the surface becomes fibrillated. This attack is restricted to the surface of the wood and the strength of the unaffected area is not impaired. However, severe thinning of the wood will occur wherever cascading water has an opportunity to wash away the surface fibers. In serious cases, the loosened fibers have caused plugging of the screens and tubes, and have served as focal points for corrosion at areas where the fibers accumulate in heat exchange equipment.

Chemical attack most frequently occurs in the fill section and flooded portions of the tower where water contact is continuous. However, it will occur also in those areas where alternately wet and dry conditions develop—such as on the air intake louvers and other exterior surfaces. Chemical attack occurs also in the warm, moist areas of the plenum chamber of the tower caused by chlorine vapors and entrainment of droplets of tower water.

Biological Attack

Biological attack of cooling tower wood can be divided into two basic types . . . soft or surface rot and internal decay. These two types of deterioration are characterized by the effect they produce. *In general, biological attack is insidious. It can proceed relatively unnoticed for long periods of time and then can manifest itself suddenly . . . and disastrously.*

The organisms that are responsible for attack of cooling tower wood are those that can utilize cellulose as their source of carbon in their growth and development. Degradation of the cellulose is accomplished by the secretion of enzymes which convert the cellulose into compounds that can be absorbed by the organisms. The attack tends to deplete the cellulose content of the wood and leaves a residue rich in lignin. Characteristically, the wood becomes dark in color and loses much of its strength. The wood also may become brash, soft, punky, cross-checked or fibrillated. The principal cellulolytic organisms isolated from cooling tower wood are primarily fungi, which include the classical wood destroyers (Basidiomycetes), and members of Fungi Imperfecti. However, bacterial organisms that exhibit cellulolytic properties also have been isolated but their exact role in cooling tower wood deterioration is yet to be determined. The wood destroying organisms are common air and water borne contaminants, and are widely distributed in nature.

The classical *internal decay* is restricted generally to the plenum areas of the tower, such as the cell partitions, doors, drift eliminators, decks, fan housing and supports. It is the more insidious of the two types of biological attack. It is characterized externally by an apparently sound piece of wood, which upon breaking shows severe in-

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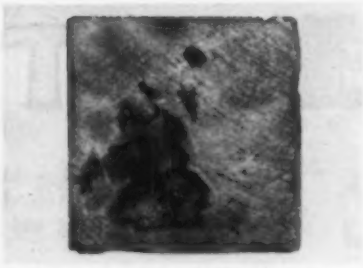
ternal decay. Because the decay is internal, it is difficult to detect in its early stages. Rarely is internal decay found in the flooded portions of the tower such as the fill section. In these sections, the wood is saturated completely with water which excludes oxygen from the interior of the wood. The absence of oxygen limits the growth and development of these organisms.

Soft or surface rot is found predominantly in the flooded sections of the tower but also occurs in the plenum areas. The water flowing over the wood surfaces in the flooded portions contains enough oxygen to support growth. Surface rot is detected more readily, and its effect is less severe than internal decay.

In addition to oxygen—moisture and temperature have a marked bearing. Locations where the moisture content of the wood range between 20 and 27% and temperatures range between 88 and 105 F, usually permit optimum growth and development of the organisms.



Internal biological attack.

Chemical deterioration as manifested by delignification can be controlled readily by restricting the pH and chlorine concentration of the circulating water. It is advisable to restrict the pH below 8.0 and preferably in the range of 6.0-7.0. In this range, the alkaline salts will be at a low level, the rate of leaching of extractives will be slower and the adverse effect of chlorine will be lower. It is also advisable to restrict the free chlorine residual to no more than 1.0 ppm, or preferably lower. Intermittent chlorination is preferred over continuous chlorination, since the latter even at concentrations less than 1.0 ppm tends to promote more rapid deterioration of tower wood.

Biological deterioration of the surface type, particularly in the flooded portions of the tower, can be greatly minimized by the same factors which minimize chemical attack. There is ample evidence that chemical surface attack renders the wood more susceptible to biological surface attack. In addition to the control of pH and the judicious use of chlorine, the supplemental periodic addition of non-oxidizing biocides to the circulating water to control the causal organisms will be of material benefit.

The control of biological deterioration in the plenum areas of the tower is considerably more complicated, primarily because of the internal decay which is prevalent in these areas. *This type attack can proceed relatively unnoticed for long periods of time and then can manifest itself suddenly—and disastrously.* This statement is repeated to emphasize the insidious nature of this type attack. Thorough inspections will not always disclose the extent or presence of incipient decay. Detection is made generally only after extensive damage has been done. Infected members should be removed and replaced preferably with 'treated' lumber. Because of the random nature of the attack, and the fact that only the most seriously affected areas will be discovered and replaced, subsequent discovery of more areas of infected lumber will be uncovered with time, and maintenance and repair costs will mount.

The existing methods of control of biological deterioration in the plenum areas of operating towers involves spraying the lumber with preservatives that are toxic to the causal organisms. Impregnation of the wood relies on diffusion of the toxicants into the wood. Whereas diffusion of the toxicants through the ends of the wood members is good, diffusion across the grain is not very great, often limited to penetration of the outer ⅛" to ¼" of the member. In large members, where the internal rot is deeply seated, the toxicant will not reach the infected area and growth of the organisms can continue. Accordingly, at best the procedure of spraying the plenum areas of the tower can only help in containing the infection. *Because of this limitation it is essential that the corrective procedure be applied before the tower is seriously infected.* Therefore, for maximum benefit in minimizing biological attack of the internal type, spraying of the plenum areas of the tower should be done before serious infection has developed. The spray procedure should be adopted and viewed as preventive maintenance.

In order that serious attack be avoided, periodic examination of the tower should be augmented by submitting wood samples to a qualified microbiological laboratory. Studies of the wood can be made which will show the incidence of fungi on the surfaces and interior sections of the wood and whether cellulolytic organisms were or are present. The natural resistance of the wood should be checked to determine whether it has diminished to a point where it is no longer effective against microbiological attack. These studies can serve as a basis for determining when to initiate the preventive spraying program.

TOWER LIFE

Physical and Other Factors

One of the major physical factors is the effect of temperature upon wood. Wood technologists have long recognized that high temperatures have an adverse effect on wood. It is known that continuous exposure to high temperatures will produce gross changes in anatomical structure and will accelerate loss in wood substance. These resultant effects will weaken the wood and predispose it to biological attack particularly in the plenum areas of the tower.

There are other factors which also have a bearing on the deterioration of tower wood. For example, areas adjacent to iron nails and other iron hardware usually deteriorate at an accelerated rate. These areas invariably lose much of their strength and the wood will crumble easily in the fingers. Slime and algae growths and deposition of dust and oil can all aid the growth and development of the soft rot organisms.

Control of Wood Deterioration

While the subject of wood deterioration under cooling tower operating conditions is far from being completely understood, a considerably better understanding of the process has been gained during the last few years. With this understanding, a comprehensive program can be outlined which, if followed, will assure a minimum of attack and longer tower life.

Betz Laboratories maintain a well equipped microbiological laboratory, staffed by microbiologists with an extensive background in the field of cooling tower wood deterioration. We will be pleased to make our facilities and services available for the study of your cooling tower problems. For more details on the care and maintenance of cooling tower wood deterioration, write for Bulletin 605.

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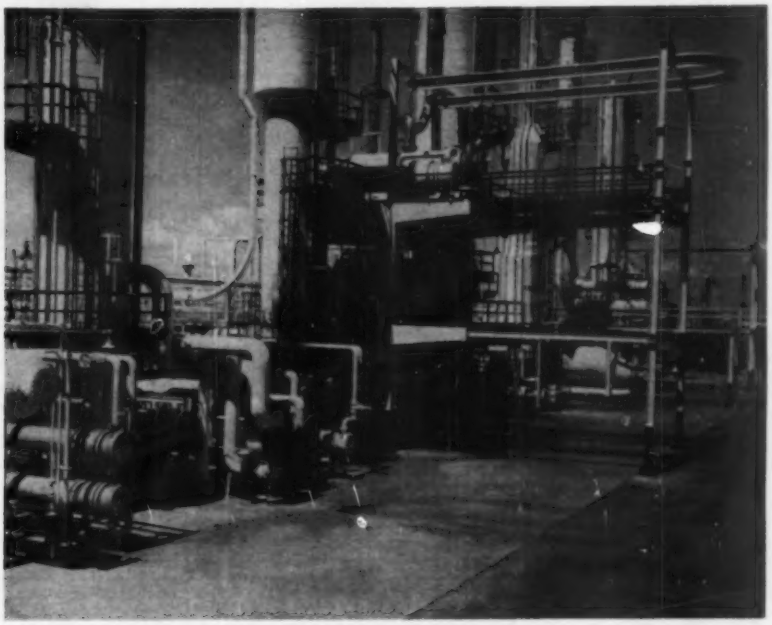
Use a "Z" Factor...

to Measure Thermal Performance

E. I. MOTTE, *Process Engineer, Union Oil Company of California*



Typical heat exchanger installation of Union Oil Company of California.

A PROCESS ENGINEER regards the apparent overall heat transfer coefficient as the usual measure of heat transfer resistance in an exchanger. As you probably know from experience, the evaluation of the overall transfer coefficient in the field is often complicated by such factors as fluid properties, flow rates, etc. To simplify this problem, we developed a heat transfer resistance "factor" proportional to the inverse of the overall heat transfer coefficient . . . one that eliminates most of the bothersome problems.

Specifically this "factor" was developed as an easy means to follow the fouling rates of certain critical exchangers when rate data was unavailable for either fluid . . . and a heat transfer coefficient could not be calculated. We call this a "Z" factor.

To be effective, a performance "factor" should be:

- proportional to the heat transfer coefficient so that percentage of clean performance can be calculated.
- ease of calculation so that foreman and operators can figure and plot the fouling of exchangers.
- independent of flow rate.
- independent of fluid properties.

We believe that the "Z" factor fulfills most of the objectives.

"Z" factor is defined:

$Z = \Delta T_{LM}/\Delta t$ — for no phase change on side Δt is measured

$Z = \Delta T_{LM}/(\Delta t + \Delta H/C_p)$ — for complete phase change on side Δt is measured

where Z = Heat transfer resistance factor,

ΔT_{LM} = Corrected log mean temperature difference,

Δt = Temperature change across tube or shell of exchanger,

ΔH = Latent heat of vaporization of fluid for which Δt is calculated,

C_p = Heat capacity of fluid for which Δt is calculated.

Derivation of Heat Transfer Resistance Factor "Z"

Since fouling of an exchanger is a linear function of the inverse of the heat transfer coefficient as shown in Equation 1, the heat transfer resistance factor "Z" should be proportional to the inverse of the heat transfer coefficient.

$$\frac{1}{U_D} = \frac{1}{U_C} + F \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where F = fouling resistance

U_C = clean heat transfer coefficient

U_D = dirty heat transfer coefficient

A heat transfer resistance factor Z will be developed for two cases:

1. **No Phase Change**

The following equations describe the total heat transferred in an exchanger when there is no change of phase occurring:

$$Q = U_1 A \Delta T_{LM} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$Q = R_1 C_{p_1} \Delta t_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where A = heat transfer area
C_{p_1} = heat capacity of material on side 1
Q = total heat duty
R_1 = mass flow on side 1 of exchanger
U_1 = over-all heat transfer coefficient
ΔT_{LM} = corrected log mean temperature difference
Δt_1 = temperature change of fluid on side 1 across the exchanger

Equating Equations 2 and 3 and rearranging terms, we obtain:

$$\frac{\Delta T_{LM}}{\Delta t_1} = \frac{R_1}{U_1} \frac{C_{p_1}}{A} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The terms C_{p_1} and A will be essentially constant for an exchanger in a particular service while the terms U_1 and R_1 will vary.

MEET THE AUTHOR

E. I. Motte, process engineer for Union Oil Company of California, Rodeo, is a licensed professional engineer in California and holds bachelor's and master's degrees from the University of California. His professional affiliations include membership in the American Institute of Chemical Engineers.

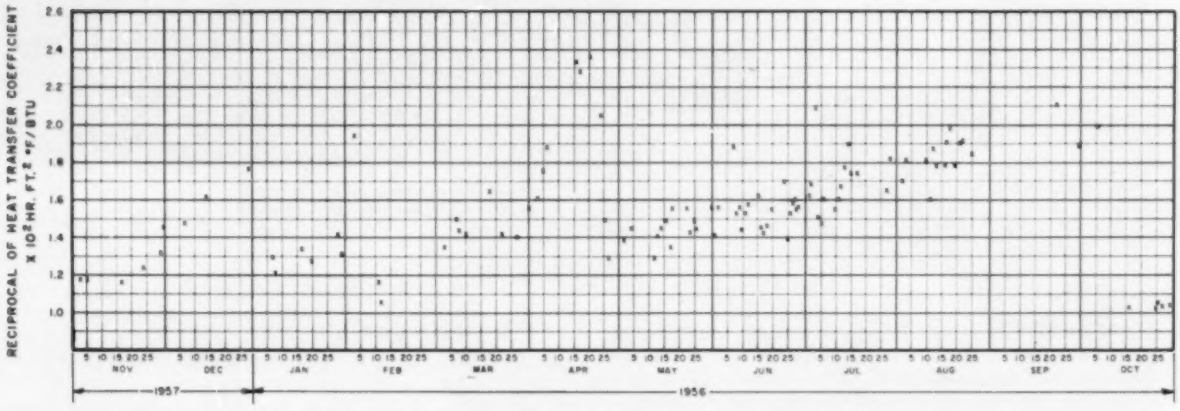


FIG. 1. Reciprocal of heat transfer coefficient — crude unit preheat exchanger.

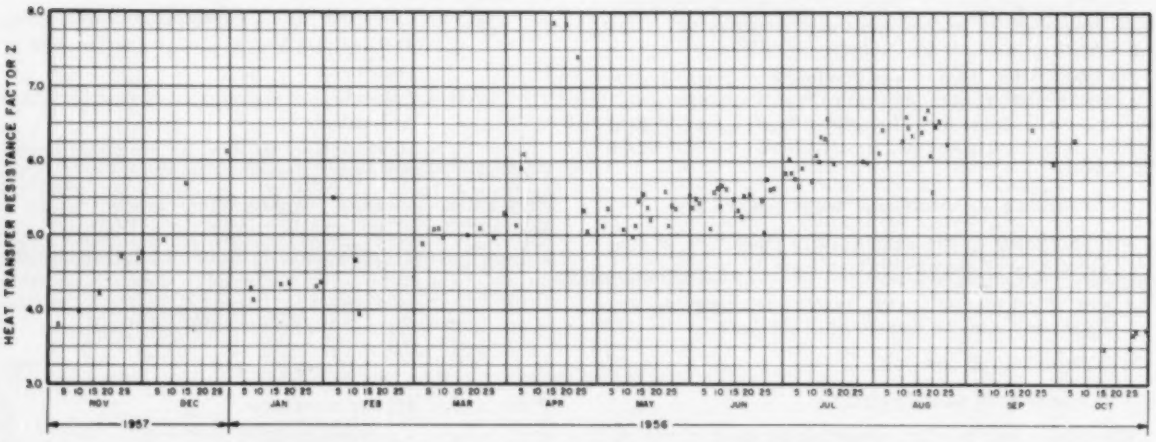


FIG. 2. Tube side heat transfer resistance factor "Z" — crude unit preheat exchanger.

Since the heat transfer coefficient is a function of velocity, it is common practice to correct the heat transfer coefficients to a common rate by the following equation:

$$U_o = U_i(R_o/R_i)^{0.8} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where

U_i is the uncorrected heat transfer coefficient

U_o is the corrected heat transfer coefficient

R_i is the rate at which U_i is determined

R_o is the constant rate to which U_i is corrected

Substituting Equation 5 into Equation 4, we obtain:

$$Z = \frac{\Delta T_{LM}}{\Delta t_i} = \frac{(R_i)^{0.2}}{U_o} \frac{(R_o)^{0.8}\, C_{p_1}}{A} \quad . \quad . \quad (6)$$

The factor "Z" is essentially proportional to the inverse of the overall heat transfer coefficient U_o corrected to a constant rate R_o. The factor "Z" is still dependent on rate to the 0.2 power but this should not cause significant errors when using the factor "Z" because the rate through a particular exchanger does not usually vary over a wide range.

2. Complete Phase Change

Heat transfer in an exchanger in which there is a complete change of phase can be described by Equations 7 and 8 if the following assumptions are made:

a. The amount of superheat or subcooling does not radically affect the log mean temperature difference.

b. The heat of evaporation is based on either the inlet or outlet exchanger conditions.

c. The material on side 1 either has the same liquid and vapor heat capacity or is not superheated and supercooled in the same exchanger.

$$Q = U_i A \Delta T_{LM} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

$$Q = R_i (\Delta H_i + C_{p_1} \Delta t_i) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

where A = heat transfer areas

C_{p_1} = heat capacity of material on side 1

Q = total heat duty

R_i = mass flow on side 1 of exchanger

U_i = overall heat transfer coefficient

ΔH_i = heat of evaporation of material on side 1

Δt_i = temperature change of fluid on side 1 across the exchanger

ΔT_{LM} = corrected log mean temperature difference

Combining Equations 7 and 8 with Equation 4, which corrects the over all heat transfer coefficient to a constant rate results in:

$$\frac{\Delta T_{LM}}{C_{p_1} \Delta t_i + \Delta H_i} = \frac{(R_i)^{0.2}}{U_o} \frac{(R_o)^{0.8}}{A} \quad . \quad . \quad (9)$$

Multiplying both sides of Equation 9 by C_{p_1}, we obtain:

$$Z = \frac{\Delta T_{LM}}{\Delta t_i + \Delta H_i / C_{p_1}} = \frac{(R_i)^{0.2}}{U_o} \frac{(R_o)^{0.8}\, C_{p_1}}{A}$$

$$. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

The factor "Z" is essentially proportional to the inverse of the overall heat transfer coefficient corrected to a constant rate R_o.

Note that Equations 6 and 10 are identical except for the term $(\Delta H_i/C_{p_1})$ which has been added to the denominator of "Z" for the case of a complete phase change. For most hydrocarbons $\Delta H_i/C_{p_1}$ will be approximately 300.

The reciprocal of the heat transfer coefficient and the heat transfer resistance factor for a crude unit preheat exchanger is shown in Fig. 1 and 2. The data in Fig. 1 and 2 are shown only to compare the results of calculating a heat transfer coefficient versus the simpler "Z" factor. The trends are identical in both figures. The October break shows the change due to cleaning the exchanger during a turnaround. The cause of the April scattering in both the heat transfer coefficient and "Z" factor plots is unknown but is believed to be fouling of a temporary nature because the rate was not reduced during this period.

The heat transfer resistance factor "Z" has also been found to be proportional to the overall heat transfer coefficient in partial condensers. Complete phase change or no phase change can be assumed in calculating the factor "Z" for a partial condenser, depending on the amount of sensible and latent heat transferred in the partial condenser. The overall heat transfer coefficient for a reforming unit partial condenser in which the amount of latent and sensible heat transferred are approximately equal is correlated with the heat transfer resistance factor in Fig. 3.

Each of the many factors involved in calculating a heat transfer coefficient contain some uncertainty which is magnified in the heat transfer coefficient. These errors cause the calculated heat transfer coefficients to scatter so that it is sometimes difficult to determine an apparent fouling trend. Since there are fewer factors involved in the heat transfer resistance factor "Z," this factor should have a lower standard error, making it easier to determine a fouling trend. ★

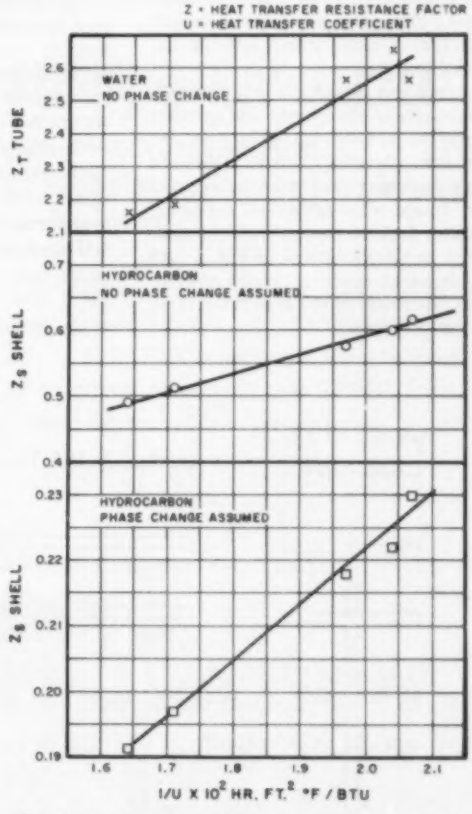


FIG. 3. "Z" factor vs 1/U for a partial condenser with and without a phase change.

How to design pipe supports

. . . for Petrochemical Plants

ONCE the routing of pipes has been roughly established, the type of pipe supports, best suited for the particular case, has to be determined. Pipe supports can be grouped in three categories: Overhead, at grade, and underground.

Overhead Pipe Supports

Overhead pipes running in groups can best be supported by freestanding structural frames. For widths up to 8 ft, a column "T"-support, as shown in Fig. 1, will be most economical.

For wider supports, a freestanding two-column frame should be used, as shown in Fig. 2. In order to use the beam most effectively, columns should not be placed at the ends of the beam (Fig. 3). Instead, the beam should cantilever out over the columns (Fig. 2) with the most economical length of cantilever being one-fourth of the column spacing.

For column spacing wider than 25 ft, it usually is cheaper to add another column to reduce the span and the beam size. Generally, on all overhead pipe supports, rather than going to a wider frame with additional columns, a second deck of pipes should be considered as shown dotted in Fig. 1 and 2. This saves space at grade and requires less material to support the same number of pipes.

Within a plant unit, a row of pipe supports usually runs parallel to a row of equipment and pipes have to leave or enter the pipeway. The tendency is to provide beam-struts longitudinally between adjacent pipe supports in order to provide support for the turning-off pipes. This is a costly procedure, because of the added amount of structural materials.

Often, pipes leaving the pipeway can be hung from other pipes or supported by a "dummy" pipe extension on the elbow as shown in Fig. 4. Only when the location and number of pipes warrants it, should a beam strut between two pipe supports be used.

However, once the need for many struts on a particular run has been established, the whole group of supports can be designed as fully strutted pipe supports (Fig. 5) by filling in the missing numbers. With strutted supports the engineer can utilize the axial strength of the struts to brace the supports. This is advantageous in that, with strutted supports, pipes can be anchored on any support without additional vertical bracing. The advantage is apparent if compared to independent self-supporting pipe supports. Here, pipes have to be anchored in groups on a few selected supports because every group of anchor points on an

BRUNO LAAN
Principal Structural Engineer
The Fluor Corporation, Ltd., Los Angeles, Calif.

FIG. 1.

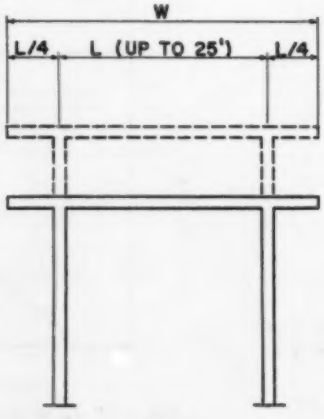


FIG. 2.

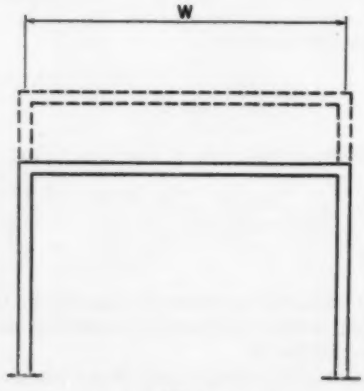
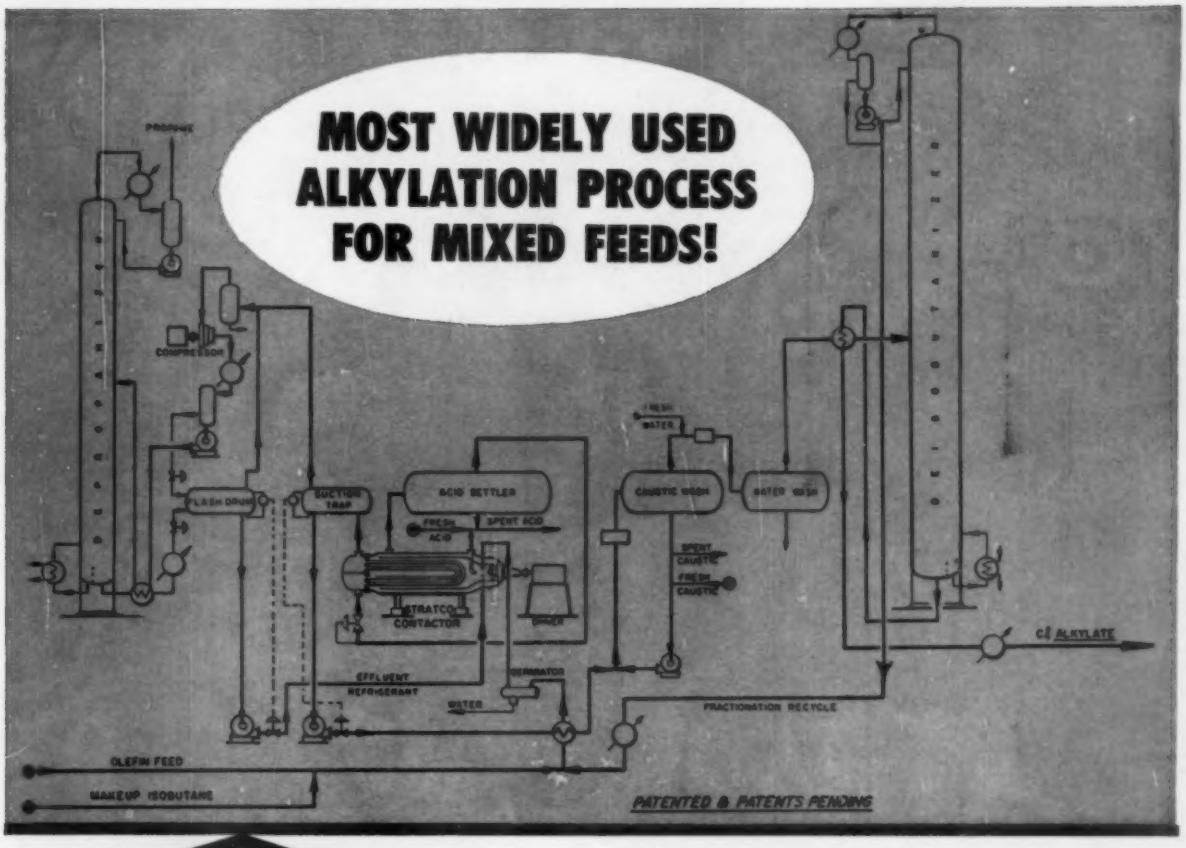


FIG. 3.



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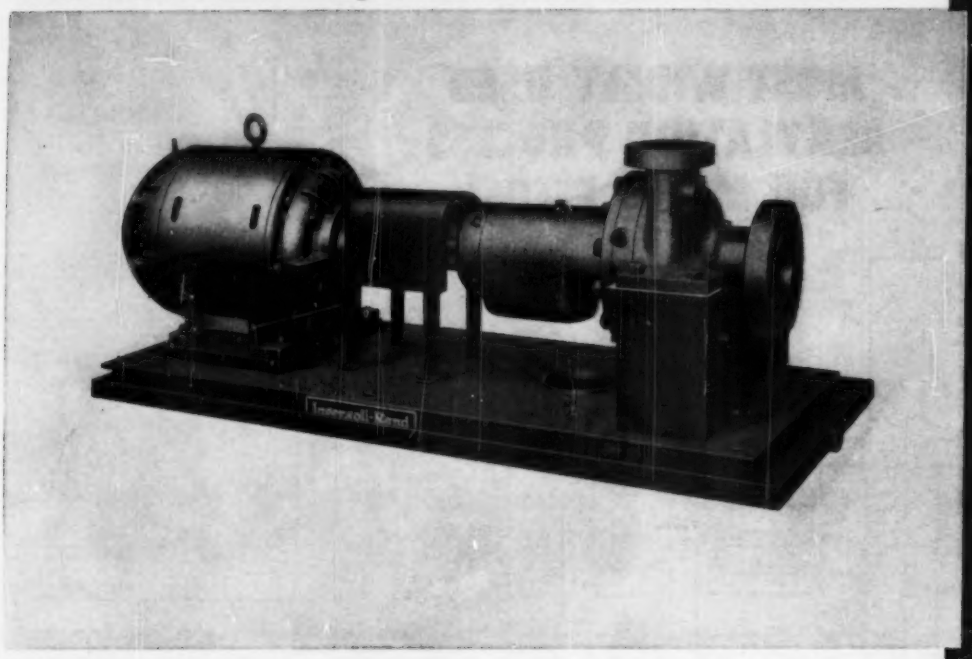

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independent support has to be braced to an adjacent foundation.

In 1958 a new consideration involving labor unions was added to the problem of choosing between self-supporting and strutted pipe supports made of structural steel. Under the new trend single column "T"-supports and double column frames are fabricated and erected by pipefitters. If the supports are strutted or have three or more columns they are then fabricated and erected by ironworkers.

Pipe supports fastened to buildings on structures should be designed with due consideration to their effect on the parent structure. Obviously, the existing plus the induced stresses in the parent structure, as well as the soil bearing, have to stay within allowable limits. Further, it is important that the members to which the pipe support is connected will not deflect excessively under the new loads. In most cases a pipe in service behaves like a continuous beam. Thus, a deflecting support will cause a change in the load distribution. This in turn may overstress the adjacent supports, create pockets in pipeline, and overstress the pipe itself.

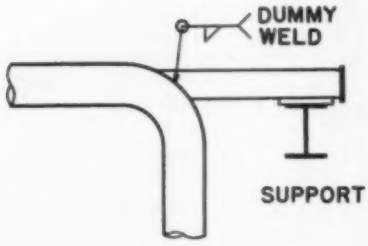


FIG. 4.

The connecting of pipes, which are subject to pulsation or vibration, to building frames or light structures should be avoided. If possible such pipes should be connected directly to a foundation or to a substantial floor slab on grade. As a rule of thumb a weight equal to or exceeding five times the weight of pipe and contents will offer enough mass to resist pulsation forces created in the pipe.

Pipe Supports at Grade

The least expensive way to support pipes is on pipe sleepers at grade. Rectangular concrete beams are poured directly into trenches with their tops formed above grade. Steel slide plates are cast in the top of the beam if required.

Supports for Underground Pipes

Most refinery underground pipes need no support. However, large concrete or clay pipes may need lateral support. This is accomplished by proper pipe bedding and backfilling according to loads and soil conditions. The engineer should specify this procedure at the time of selecting the pipe, as it might be the controlling factor for the selection of the pipe strength.

At times the available plot for a refinery may be in a swamp. In cases like this the problem of pile supports for underground pipes should not be underestimated. In the past it has been difficult to convince people about the need of piles for underground pipes at some locations. On one recent instance, some of the pipes had settled up to 9-in. and trouble at equipment nozzles was imminent. At that time piles were added to remedy the situation. The need for piles should be based on an evaluation of the results of soil investigation.

Piles for underground pipes, where needed, are usually located in pairs at 20 to 30 ft intervals. It should be noted that the pipes should be strong enough to support the overlying soil plus any additional loads on the soil directly above the pipes. For calculation purposes the pipes are considered as beams spanning between pile caps.

Selection of Materials

Before selecting materials for pipe supports the requirements relative to fire resistance have to be known. Within a refinery unit, generally, members carrying the vertical load of pipes have to be made of fireproof materials. Off-site supports can be built of noncombustible materials but without holding to specific fire resistance requirements. Wood, being a combustible material, can be used only for temporary supports during construction.

Where no fireproofing is required, overhead pipe supports can be built most economically using structural steel. Other advantages in the use of structural steel shapes are the ease in making changes and additions, future rework, strengthening, or even relocating the pipe supports.

The same advantages apply if supports are built of pipe, except for the cost of materials which may become prohibitive. In instances where large amounts of scrap pipe are available, it may be economical to use it for pipe supports.

Where fireproofing is required, precast reinforced concrete frames cast in construction area have generally proved to be some 20 percent cheaper than fireproofed structural steel frames. In cases where independent concrete casting yards are close to construction areas the cost of precast concrete pipe supports can actually equal the cost of structural steel supports without fireproofing.

Poured in place concrete frames cost about as much as fireproofed steel frames. With the latter, some saving may be made by fireproofing the steel members before erection. Only the connections will have to be left bare until the members are in place.

For fireproofed construction the choice of materials and methods of erection would depend on the possible shortages of some materials in the area, the availability of a concrete casting yard nearby, the erection and concrete placing equipment on hand, and the relative cost of materials in the area.

Details of Construction

The apparent economy of one material over the other can be wasted by improper details of construction. With structural steel, the shop and especially the field connections would have to be simple, but effective. Similarly the economy of precast concrete sections

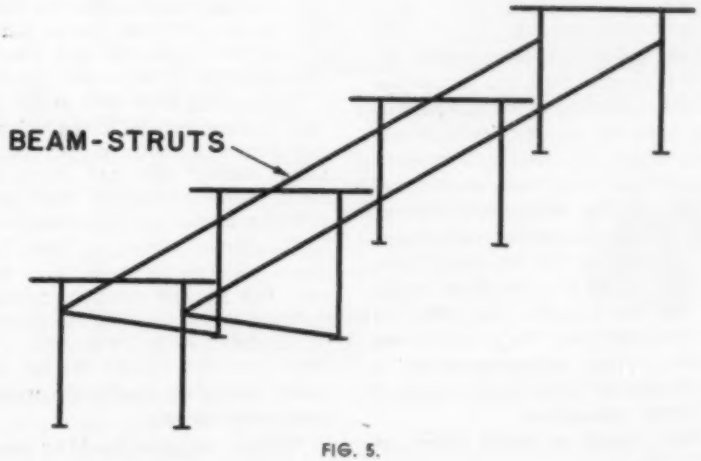


FIG. 5.

would depend largely on the ease of erection.

Because many overhead pipe supports tend to be alike in their general features, a good set of standard pipe supports and details can be worked out for various heights and widths of the supports. Thus, for the majority of conditions, members sizes and connection types can be picked from these standards for best economy.

Structural steel pipe support connections should be considered next, in order to establish a good set of standards. In areas where the cost of field labor is very high compared to shop labor, it pays to eliminate field welding entirely. Field bolted connections can be made rapidly without having to perform an extra welding operation. Obviously this reduces the field costs. Bolted connections usually require more shop work and the steel fabricator may add slightly to the unit price of the steel. However, the latter is seldom the case. On the other hand, where the cost of field labor is comparable to shop labor or the supports have to be field fabricated, then all-welded connections would be the most economical.

When working in an existing refinery, welding might not be permitted in the unit at the time of erection. This, of course, leaves no other choice but to use field bolted connections.

Fig. 6 through 9 show one proven way of making field-bolted and field-welded pipe support connections economically. It should be noted that to facilitate fabrication, punching is done only on one member in a joint. Further, the tops of columns in Fig. 6 through 8 need not be cut exactly as the length of columns can be adjusted with clips.

Precast concrete pipe supports have not received their just share of attention in literature. Fig. 10 represents details of supports which have been used successfully.

Precast members are usually cast on a flat surface with side forms only, similar to tilt-up construction. This presents a few limitations which are easily overcome. First, the bottom and top of the member in the cast position have to be flat and nothing may protrude through the bottom. Second, the two sides may have beam seats formed as shown in Fig. 10, but bolts through the side forms are detrimental to future use of the forms. So, instead of bolts, concrete inserts or weld plates should be used for hangers, slide plates or future connections. This in itself leaves a more pleasing appearance as well as a wider choice for the exact location of the future connections.

Third, braces at anchor points can

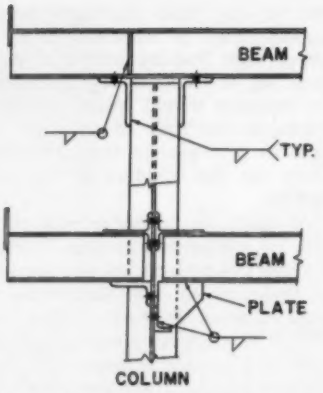


FIG. 6. Field bolted connections for free-standing pipe supports.

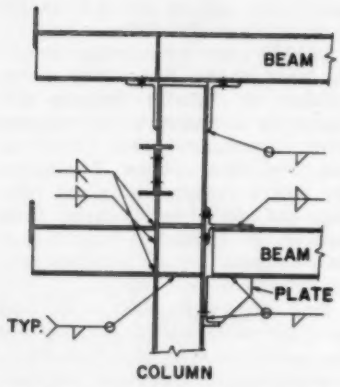


FIG. 7. Field bolted connections for strutted pipe supports.

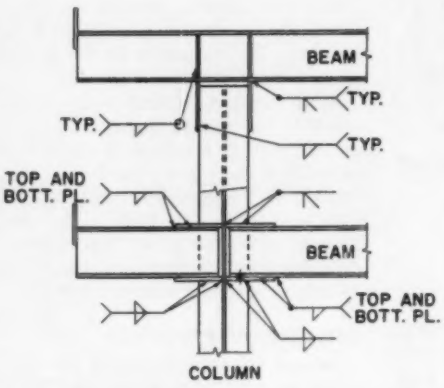


FIG. 8. Field welded connections for free-standing pipe supports.

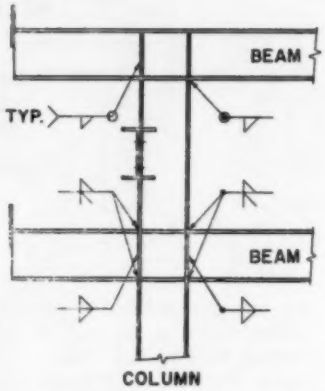


FIG. 9. Field welded connections for strutted pipe supports.

be fastened to weld plates previously cast into concrete. As the braces commonly do not need to be fireproofed, they can be made of two structural steel angles, back to back.

Detail "C" of Fig. 10 shows a method of placing a column into a rectangular hole in the foundation. The column can rest on grout plates or sand. Wood wedges can then be driven vertically to hold and later to plumb the column. Next, the beams can be set over their anchor bolts in the columns and rest on shims until grouted.

The erecting crew with cranes can thus proceed rapidly lifting columns and beams to their proper places. Later, another crew can plumb columns, adjust elevations, and grout members to their final positions.

As another variation, steel base plates with anchor bolts have been used for precast concrete columns. Actually, due to the large moment arm of the anchor bolts, the moment in the base plate may require the use of a rather thick plate, making the arrangement uneconomical.

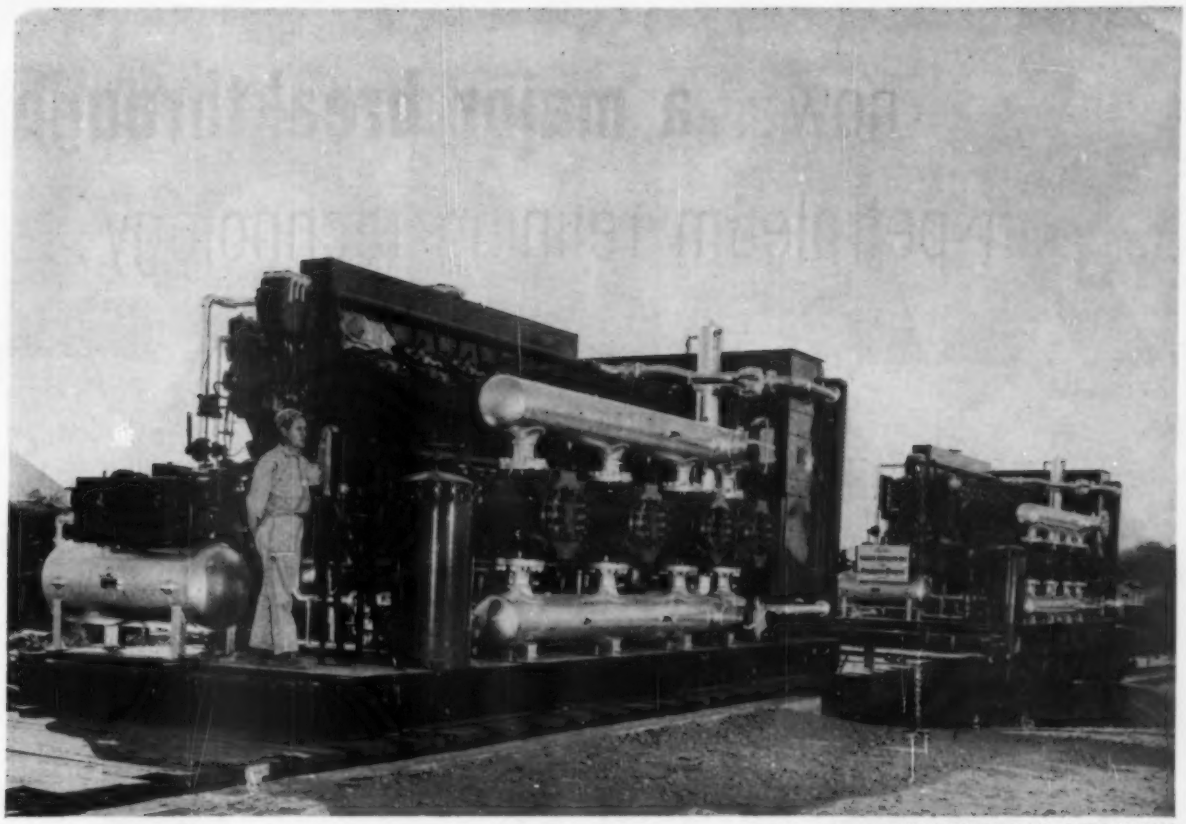
"T"-type supports should be precast in one piece and then lifted into position.

Precasting multicolumn frames in one piece has been tried, but this usually requires too much space near the erection area. Again, if the casting area is moved farther away from the erection area, then the transportation of multicolumn frames might become troublesome and the economy will suffer.

The major drawback for poured-in-place concrete pipe supports is the extensive scaffolding required to hold the forms for few small beams. This is the main reason for the high cost of such supports. The details for poured-in-place concrete pipe supports are usually made quite similar to any concrete frame details and will not be discussed further in this article.

In order to avoid the column bottom connection on precast pipe supports, a method of first casting columns in place and then lifting precast beams into position has been used quite successfully.

With this method scaffolding is eliminated and the cost of column forms can be lowered by the use of cylindrical



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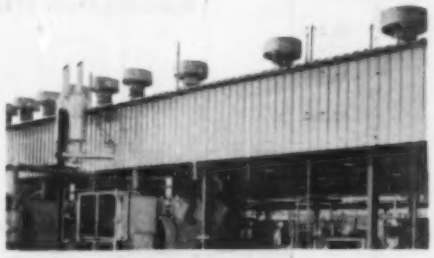

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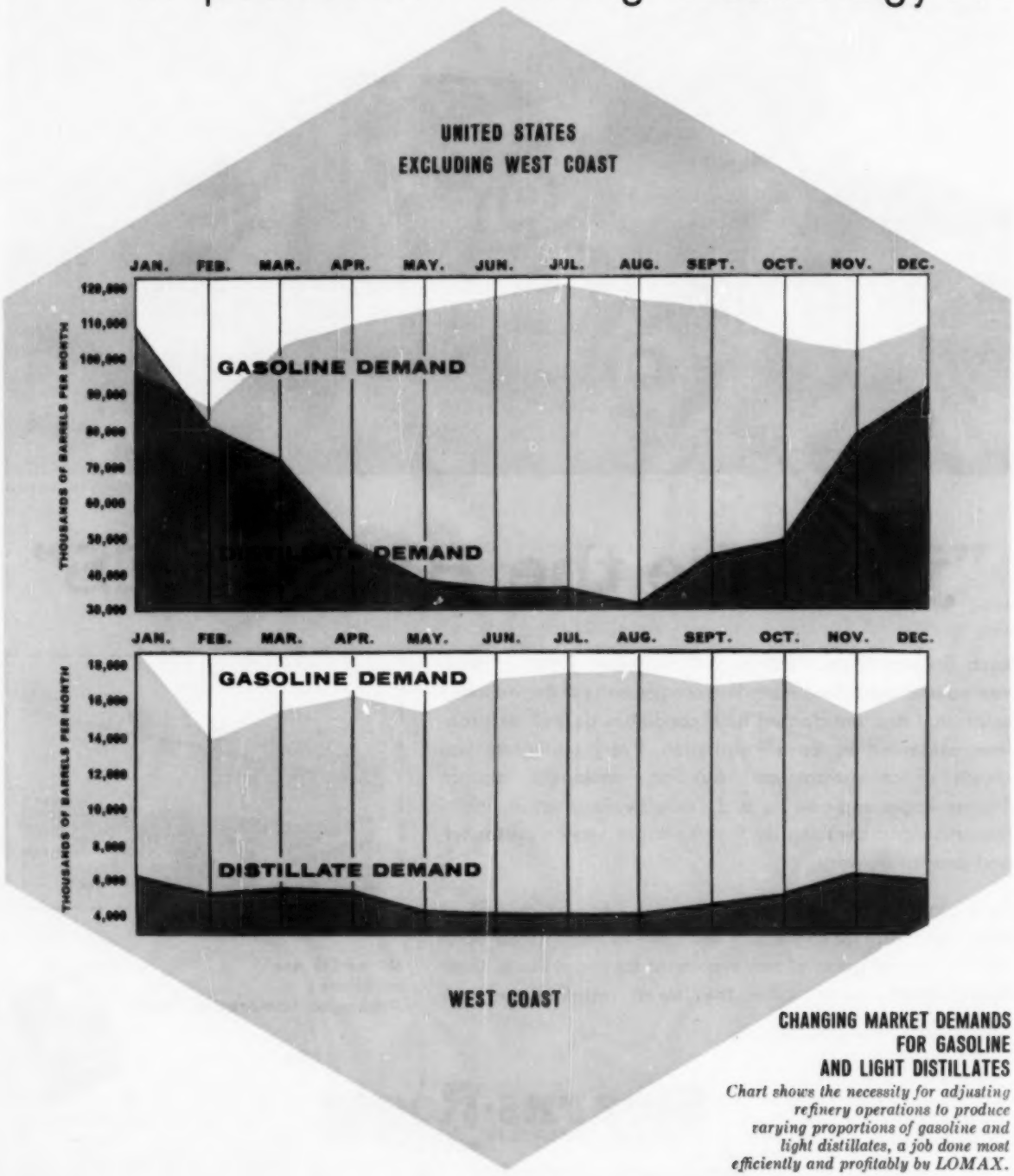

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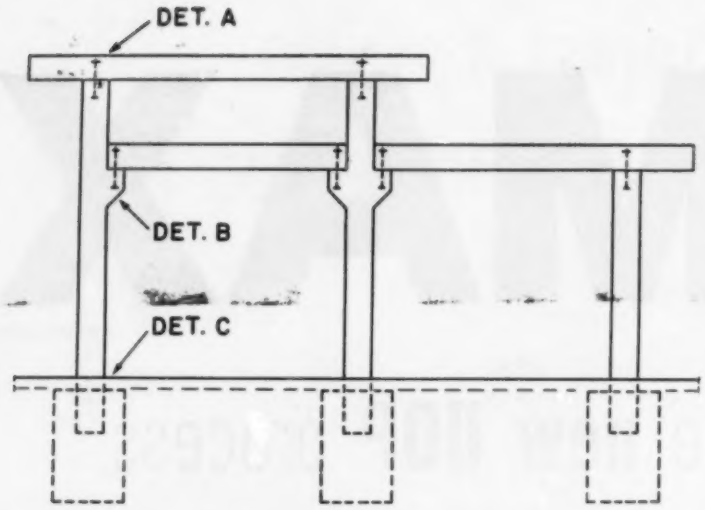
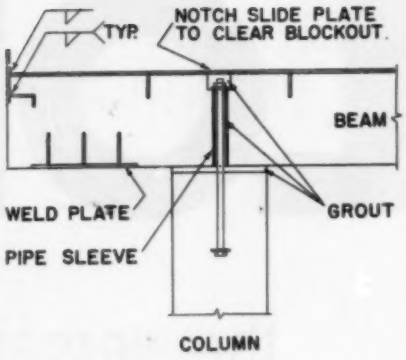
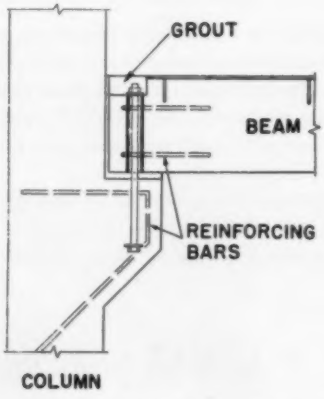


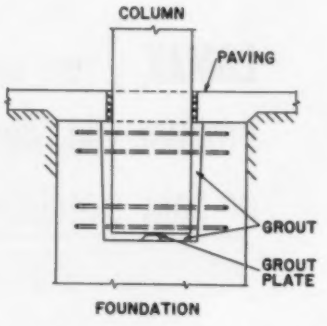
FIG. 10. Precast concrete pipe supports.



Detail A. Section at center of support.



Detail B. Section at center of support.



Detail C. Section at center of support.

fiber forms. These forms can be set vertically on the mat with the dowels from the mat lapping the vertical column steel inside the forms.

Fiber forms have many advantages. Their in-place cost is lower than the cost of in-place lumber forms, and the resulting circular column is very efficient for bending about two axes as well as for torsion. Further, the deposited concrete will be well cured if the fiber forms are left in place. There are also some disadvantages when using fiber forms, such as protection from the weather when storing before use and the problem of bulky storage. Although the forms can be cut easily with a saw, the cut has to be protected by wax or paint.

In summary, it can be said that cylindrical fiber forms are excellent for one level pipe supports. But for two level pipe supports the connection of the lower beam can be more involved. An additional drawback also can develop where the construction crews are not flexible enough to learn the use of new materials.

Design Criteria

In order to design a pipe support, the forces acting on the support have to be known. It is time consuming to calculate the exact tributary weight of each known pipe on a particular support. Besides, in petrochemical plants on new pipe support runs 10 to 25 percent of the support width is usually left empty for future use. At the design stage estimating the future pipe sizes can be a real problem.

From past experience it has been found that a standard loading can be used for the design of nearly all overhead pipe supports in a refinery. Such standard loading can be represented by 6-in. schedule 40 insulated pipes, filled with water and spaced at 1 ft center to center. A set of pipe supports can then be calculated for this load. Later, individual pipe runs can be checked by inspection as to how the line sizes and spacings compare with the standard load. In most cases it will be found that with any 10 or 12-in. pipe there are usually 3 or 4-in. pipes which will reduce the total load on the beam to less than the proposed standard.

Next, six usual forces will be discussed which act on pipe supports.

1. Weight of pipes, valves, insulation, and contents during operation plus the weight of the supporting beam. Any test or emergency operating load should be considered in order to arrive at the heaviest loading. When using the previously discussed standard load, the minimum vertical load for pipe supports spaced at 20 ft will be 720 lb per ft of support width and for supports spaced at 25 ft it will be 900 lb.

2. Friction of pipes sliding on supports. The sliding is caused by the thermal expansion of pipes. As long as the pipes on one support do not all move in the same direction at the same time, the usual steel-on-steel friction factor of 20 percent should be used only on 40 to 50 percent of the pipes. When this percentage of 40 to 50 percent is combined with the friction factor, it has been found that pipe supports supporting several pipes can safely be designed by using a horizontal friction force equal to 10 percent of the total vertical load on the support.

3. Anchor forces of piping systems created due to thermal expansion of pipes or equipment. The magnitude of anchor forces as well as the number of anchored pipes can vary so widely that it is not practical to establish a standard. Each pipe support to be used as an anchor deserves individual attention. Anchor forces used should

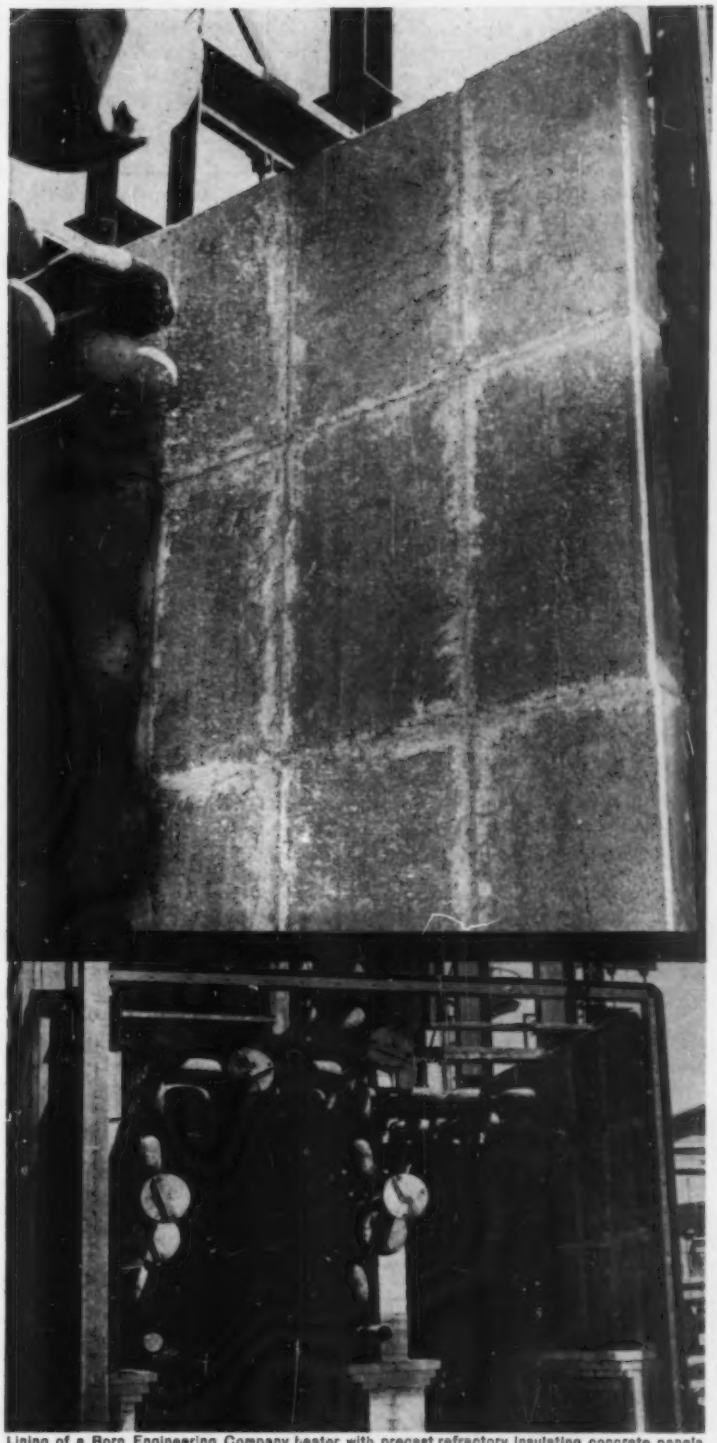
Refractory concrete protects while it insulates

For heater linings, refractory concrete made with LUMNITE calcium-aluminate cement and suitable aggregates offers two vital services. It provides a dependable heat-resistant layer for structural steel parts, and it insulates the unit to reduce heat loss (and fuel costs).

Linings of refractory concrete are light in weight, yet structurally strong through a wide temperature range. Placement is easy and economical, since refractory concrete made with LUMNITE cement can be precast, gunited, poured or troweled into place. In any case, service strength is reached within 24 hours.

For extra convenience, castables containing LUMNITE cement are available from leading manufacturers of refractories. These packaged mixtures are ready to use with just the addition of water. For more information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

L-206 "USS," "Atlas" and "Lumnite" are registered trademarks



Lining of a Born Engineering Company heater with precast refractory insulating concrete panels made with LUMNITE calcium-aluminate cement and expanded insulating aggregates. Installed by Blaw-Knox Company at Ashland Oil & Refining Company, Canton, Ohio.

Universal Atlas Cement
Division of
United States Steel

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be obtained from a stress analysis of the piping systems to be anchored.

4. Wind forces depending on the location. The applicable code should be consulted. A good wind pressure for standard pipe supports is 24 lb per sq ft acting on the horizontal projection of a cylindrical surface. This represents a 100 mph wind velocity or a 125 mph gust velocity. When several pipes are on the same support the wind pressure can be considered acting on only 40 percent of the pipes due to the shielding effect. Thus, for standard minimum loading 98 lb per ft of support width can be used for supports spaced at 20 ft and 125 lb can be used for supports spaced at 25 ft.

5. Earthquake forces based on the seismic probability of the region. A most common earthquake factor is 0.10 G for petrochemical plants in earthquake regions. Using this factor with the mentioned standard loading, the horizontal earthquake forces will be 25 percent lower than the wind forces. Thus, the wind will usually govern over the earthquake. With a higher seismic factor or a lower wind pressure this relationship has to be reconsidered.

6. Snow and ice loads should not present any special problems.

When designing pipe supports, only some combinations of the discussed forces are usually considered, because it is improbable that all the forces will act simultaneously.

For discussion purposes the horizontal forces are divided into two groups: Longitudinal and transverse forces. **Longitudinal forces** act in the direction of the pipe on the support. Friction will usually govern in this direction. **Transverse forces** act at 90 degrees to the direction of the pipe and wind will usually govern here. Longitudinal and transverse forces are combined separately with the vertical forces. Allowable stresses in materials can be increased ⅓ for the combinations.

Allowable stresses in materials are specified in the local building codes. In the absence of local building codes, the A.I.S.C. Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings, and the A.C.I. 318 Building Code Requirements for Reinforced Concrete are the basic accepted codes.

Pipe supports being of a specialized nature are not mentioned specifically in the standard building codes. The following suggestions are given as to the use of the two basic building codes.

A.I.S.C. code Section 16(b) limits the slenderness ratio (L/r) of main compression members to 200. This is based on compression members having both ends hinged. But the columns of freestanding overhead pipe supports are actually vertical cantilevers with bottom ends fixed and tops only somewhat guided. For long columns, which have one end fixed and the other end neither laterally supported nor otherwise constrained, the limiting Euler load may be obtained by observing that the shape of its elastic curve is the same as for each half of a column with hinges top and bottom. Thus for equal stiffness a freestanding column can be only half as long as a column with both ends hinged.

Since the code does not cover freestanding columns for figuring the slenderness ratio, it is proposed to use twice the actual length of the column (2L/r). As mentioned, with pipe supports the pipes themselves will somewhat guide the top of the column. Considering this, then the limit of the slenderness ratio (2L/r) is proposed to be raised to 240 for pipe support columns.

Allowable bending stresses for cantilevers are covered adequately in Section 15(a)3 of the A.I.S.C. code.

A.C.I. code Section 1107 states that the unsupported length of a long column (h/t) may not be greater than 20 times its least lateral dimension for the conventional straightline method of design of reinforced concrete. For this section of the code, there is no need to double the length of the freestanding column, because, within the range of allowable stresses, buckling will not be a consideration if the ratio h/t is less than 40 for columns with hinges at both ends.

If the concrete columns are designed according to the ultimate strength theory as reported in the appendix of the A.C.I. code (Section A611—Long members) the length of freestanding columns would have to be doubled for length to side ratios of more than 20. It should be noted, that when doubling the length with the ultimate strength theory, it is still necessary to make another check of the section using the actual length of the freestanding column.

As another suggestion to the use of the basic building codes, many engineers favor a 25 percent reduction in allowable tension for anchor bolts in a petrochemical plant due to the corrosive atmosphere. This establishes the allowable tension at 15 kips per sq in. at the root of the thread plus ⅓ increase for wind or earthquake.

Types of foundations for pipe supports depend mainly on the soil conditions and the frost line. Short drilled footings prove to be most economical if the soil is stable enough to stand without forms. Common spread footings follow closely the short drilled footing as far as cost is concerned.

If piles have to be used, pile caps can be connected for stability with grade beams in groups of fours. As the vertical load is of little consequence, only one pile may be needed under each pipe support column. Single column supports require two piles each with a grade beam in the longitudinal direction. Normally a soil report is available for a petrochemical plant site from which the best suited foundation type can be determined.

When laying out pipe supports the optimum spacing of supports must be determined. First consideration would be not to overstress piping by excessive spans. Second consideration would be the deflection limiting the span if the drainage of the pipes is important.

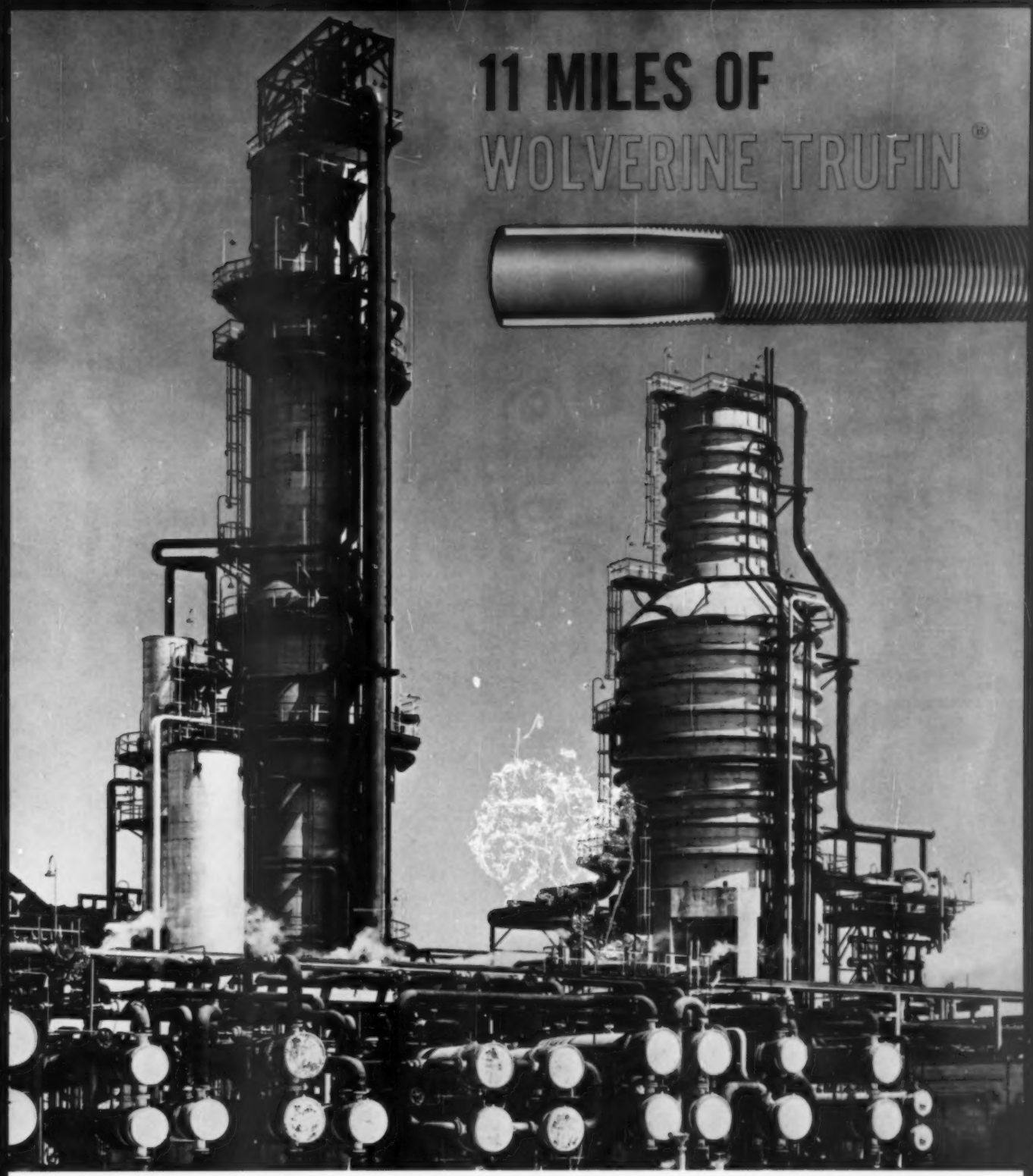
Maximum spans will result in best economy. A good starting design is 25 ft from support to support. Intermediate pickup supports, hung from large pipes (preferably cold), should be used to support small pipes unable to span the 25 ft. The spacing of supports must be shortened if the majority of the pipes is under a 4-in. size. Aluminum or other special material pipes may also require a closer spacing of supports.

When establishing the height of overhead pipe supports the supports must satisfy the following minimum clearances:

- above stairways 7 ft 6-in. clear;
- lowest level 8 ft 6-in. clear from high point of grade or paving;
- over roadways 14 ft 0-in. clear from high point of grade or paving;
- over railroads 22 ft 6-in. clear from top of rail.

Bruno Laan *is principal structural engineer of the Design Engineering Department, The Fluor Corporation, Ltd., Los Angeles, a position he has held since 1954. Previously a Fluor design engineer back to 1951, he joined the company immediately after he won an S.M. Degree in civil engineering from M.I.T. Prior to his graduate work, he worked for Bethlehem Steel Company. Laan was born and went to lower schools in Estonia. He began his university studies in Munich, Germany in 1946, later transferring to Tufts University where he took a BS Degree. Laan is a licensed civil and structural engineer in California and a licensed civil engineer in Louisiana.*

Originally presented before the ASME Petroleum Mechanical Engineering Conference, Houston, September 1959.



More than 11 miles of Trufin Type S/T–the integral finned tube–have been used in nine of the shell and tube heat exchangers which are the heart of the world's largest crude oil pipe still. Located in a midwestern refinery, the still is producing 140,000 barrels per day! More than 95% of the Trufin involved is made from Admiralty Brass.

Yes, 11 miles of Trufin is a lot of tube–but just visualize the space savings that Trufin has provided. To perform the same heat duty as Trufin, more than 20 miles of prime surface tube would have had to be used. The advantages are obvious–fewer tubes, fewer shells, much less space required, and more production.

The complete range of finned tube products made by Wolverine Tube is shown on the other side of the page. It's a product line proven by experience.

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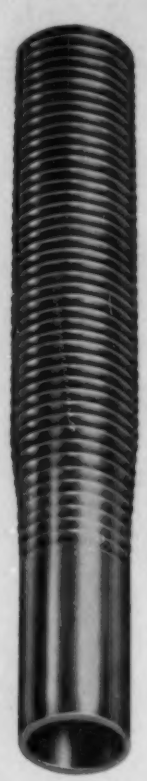


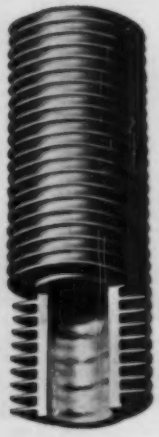
WOLVERINE TRUFIN TYPE W/H

DUPLEX PRIME SURFACE TUBE

DUPLEX WOLVERINE TRUFIN, TYPE S/T

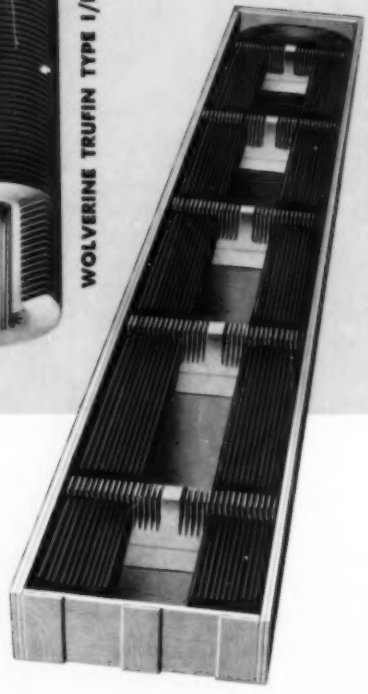
WOLVERINE TRUFIN TYPE L/C
Bimetal

WOLVERINE TRUFIN TYPE H/R



WOLVERINE TRUFIN TYPE H/A

WOLVERINE TRUFIN TYPE I/L



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world and points out how an individual's success depends to a large extent on his ability to communicate effectively with his employers, employees, and colleagues. This is first of series designed to help engineers to develop and improve their personal and professional talents. *Western Supply Company.*

Circle number (47) on reply card.

Gage Illuminators . . . are subject of 2-page data sheet No. 375, which covers features and sizes of Jerguson Explosion-Proof Illuminators. These UL and CSA-approved units give a bright, evenly diffused light over the entire length of the gage glass. *Jerguson Gage & Valve Co.*

Circle number (48) on reply card.

Gravity fillers . . . designed for effective and economical packaging of free-flowing liquids, are detailed in Bulletin 986. Units come with either 9, 12, 14, 18, or 24 filling stations, and filling speeds range from 35 to 400 cpm, depending on machine model, can size, and product filled. *The Pfaudler Co.*

Circle number (49) on reply card.

Havelex . . . formerly G. E. Mycalex, custom molded inorganic insulation, is discussed in new bulletin. Material is composed of special glass reinforced with mica. *Haveg Industries, Inc.*

Circle number (50) on reply card.

Hexahydrophthalic Anhydride . . . its characteristics and suggested uses, are detailed in Brochure I-2R. Product is used in manufacture of alkyd resins, coatings, adhesives, resins, insecticides, and as a synthetic lubricant for diffusion pumps. *National Aniline Division, Allied Chemical.*

Circle number (51) on reply card.

Hortonclad . . . high vacuum bonding process is described in new booklet which tells how by this method it is practical to fabricate process equipment, tanks, and other clad structures which provide the same benefits as solid corrosion resistant material and at substantially less cost. *Chicago Bridge & Iron Company.*

Circle number (52) on reply card.

Industrial and Marine Strainers . . . are detailed in Tate Strainer Guide, 88-page handbook which contains a compilation of reference data for layout of fluid flow systems and sizing of strainers, tabulated results of testings in company's research facilities, and valve and pipe selection information. *Tate Engineering, Inc.*

Circle number (53) on reply card.

Industrial Type Battery Chargers . . . are covered in three bulletins as follows: No. 237, automatic chargers; No. 236, trickle chargers with output range of 50 to 200 ma; No. 203, battery chargers with output range of .05 to 2.0 amp. *Automatic Switch Company.*

Circle number (54) on reply card.

Instructions for New Procedure . . . in taking boilers off line may be obtained from consultants on industrial water problems. *Betz Laboratories, Inc.*

Circle number (55) on reply card.

Jet-Driven Gas Turbine . . . is subject of 8-page brochure No. 95 which gives concept and operating characteristics of company's RT-248 Gas Turbine. The new unit has potential application in refinery and process plants for compressor and pump drives. *Cooper-Bessemer Corporation.*

Circle number (56) on reply card.

Kelonite Graphite Burst Discs . . . are topic of new catalog which gives sizes and burst ratings, description of metal holders, information on low pressure disc series, capacity tables, installation instructions, standard dimensions. *Kearney Industries, Delanium Graphite Division.*

Circle number (57) on reply card.

PETRO/CHEM new literature

Analog In-Process Computers . . . developed for the chemical, petrochemical, and refining industries, are explained in 4-page bulletin. *Southwestern Industrial Electronics Company.*

Circle number (41) on reply card.

Bailey Fluid Meters . . . their operation, ranges, and installation requirements are discussed in Bulletin 20, which also gives information on integrators, compensators, and primary elements. *Bailey Meter Company.*

Circle number (42) on reply card.

Balanced/Opposed Air Compressors . . . for standard 110 psi industrial applications are detailed in Bulletin 185. Specifications cover the complete line of 23 models. Strokes range from 6 to 17 in. and sizes from 75 to 2000 bhp. *Clark Bros. Co.*

Circle number (43) on reply card.

Datex Linear Encoder System . . . is explained in Bulletin No. 318, which tells how the equipment automatically measures and records on invoices or tally sheets measurements of individual pieces of tubing, rod, and long structural shapes and then totalizes the individual lengths as required. *Datex Corporation.*

Circle number (44) on reply card.

Eccentric Valves . . . are detailed in Bulletin 110, which lists features of the valves as well as materials, pressure ratings, dimensions, and accessories. *DeZurik Corporation.*

Circle number (45) on reply card.

Filtration Products Booklet . . . IND-1-60 lists and details information on various filter media for process fluids, nuclear applications, internal combustion engines, hydraulic fluids, machine tool coolants, bulk fuel, and many other applications. *Purolator Products, Inc.*

Circle number (46) on reply card.

"Fluid, Fluent Communications" . . . new 12-page booklet emphasizes importance of communications in today's business

Positive Draft Control Systems . . . are described in Catalog No. 10, which also illustrates wind control equipment manufactured by this company. *Moran Furnace & Sheet Metal Company.*

Circle number (58) on reply card.

Process Computer Control Booklet . . . "A Return to Sanity in Computer Control," provides answers in laymen's language to some common problems of computer control and gives details on a step-by-step method for developing a highly reliable computer control system with a minimum capital commitment. Bulletin S-4019. *Beckman Scientific and Process Instruments Division.*

Circle number (59) on reply card.

Scale and Corrosion Control Booklet . . . newly revised, is in form of a telescoped sheet of 11 different drums — each a Glucosate directed to some special use in correcting and controlling scale and corrosion factors. *D. W. Haering & Company, Inc.*

Circle number (60) on reply card.

Sliding Gate Pressure Regulators . . . now available in stainless steel, are described in Bulletin JNP-4. The No. 760 is used on steam, water, air, oil, gas, and many corrosive chemicals. *OPW-Jordan Corporation.*

Circle number (61) on reply card.

Small Tubing Guide . . . is an aid in fast, easy selection of tubing for any given application. Bulletin No. 42 summarizes significant properties of 84 tubing analyses in seven groups—carbon steels, stainless steels, alloy steels, nickel and nickel alloys, copper base alloys, glass sealing alloys, and reactive metals. *Superior Tube Company.*

Circle number (62) on reply card.

Valve Guide . . . describes and pictures company's line of valves; gives capacities, sizes, applications. Catalog 10-A. *R-P&C Valve Division, American Chain & Cable Company, Inc.*

Circle number (63) on reply card.

YORK Multi-Stage Turbomaster Ideal For Applications Down To 800 cfm

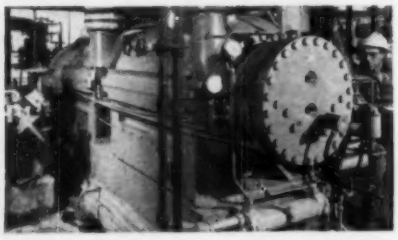
—Offers greater efficiency even for small loads

COMPACT AND ECONOMICAL—On small jobs, Turbomasters offer smoother, pulsation-free operation with virtually no maintenance. On big jobs, two small units can be used, rather than one large machine, to "spare" the system economically.

PRE-ROTATION VANE CAPACITY CONTROL—Standard on all Turbomasters, these vanes provide automatic, continuously variable capacity. This means that compressor capacity stays in direct proportion to load for high system efficiency.

OPERATE BELOW CRITICAL SPEED—Turbomasters up to 6 stages operate well below critical speed. Short, stiff shaft and lightweight aluminum rotors make this possible. Impeller assembly factory-tested at an over speed of 20% or more to insure reliability.

VERSATILE TO MEET YOUR REQUIREMENTS—Up to 8 stages in one casing with choice of casing and rotor materials and sizes, plus side loading and interstage connections to meet exacting requirements. Simple centrifugal design has 400 less parts.



Another YORK Trail Blazer Concept Proved In Action at *Wyandotte Chemicals Co., Geismar, La.*—Two 6-stage 1880 hp turbine driven tandem compressors supply refrigeration for chlorine production. Five suction connections handle 2 loads of condensing chlorine at 2 temperature levels, a water cooling load and 2 stages of refrigerant cooling.

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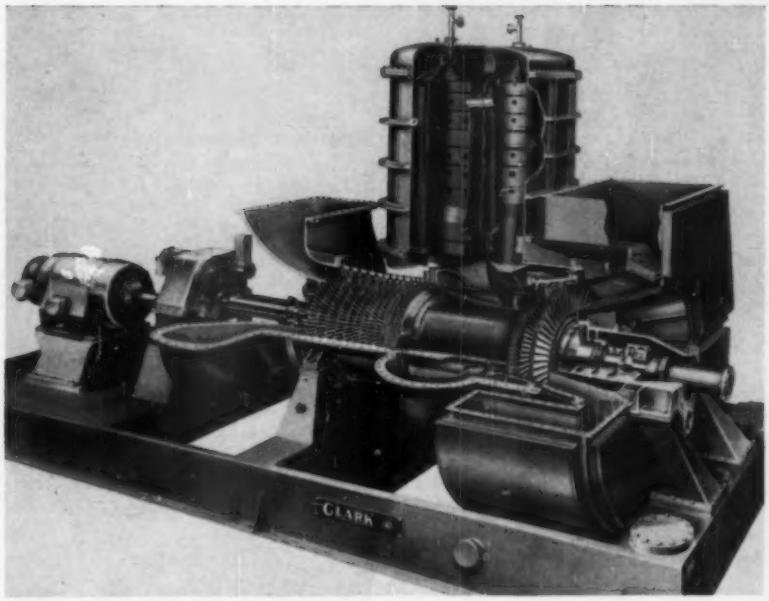


9000 bhp Single Shaft Gas Turbine

Model 305-S, new open cycle, single shaft gas turbine with NEMA rating of 9000 bhp burns either liquid or gaseous fuels and is capable of continuous operation under full load conditions at normal rated speed of 500 rpm. It provides a low cost, reliable source of rotative power for centrifugal compressors, power generators, and liquid pumps in applications requiring limited speed flexibility.

At rated speed the axial compressor delivers a mass flow of 135 lb per sec. Turbine inlet temperature is held under 1400 F to insure extra long life and a substantial margin of operating safety. Turbine is completely air cooled — pressurized air is bled off the axial compressor to cool high temperature components, while cool air envelopes between inner and outer skin surfaces reduce heat loss and minimize external temperatures wherever possible.

Depending on customer requirements, alternate starting devices such as electric motors, steam turbines, diesel engines, etc., can be provided. The turbine is furnished with its own integral force feed lubrication system.

Turbine is mounted on a fabricated steel baseplate of box type construction for maximum strength and rigidity. Frame contains an integral lube oil reservoir and is of sufficient length to provide adequate mounting for the starting device and other accessories. *Clark Bros. Co.*

Circle number (64) on reply card.

Explosion-Proof Floodlight

Type RCDE-6 explosion-proof floodlight is made with a number of mountings, making it suitable for many indoor and outdoor applications in hazardous locations. Portable model, available with carrying handle and wheelbase or with carrying handle and telescoping tripod, is convenient for maintenance and repair operations. For permanent installation the floodlight can be provided with flat base and explosion-proof junction box, or with 2 in. threaded hub on bottom of junction box for mounting on vertical conduit. *Crouse-Hinds Company.*

Circle number (65) on reply card.

High-Pressure Unions

New 4000 and 6000-lb working pressure unions have fast "make-and-break" feature which speeds and simplifies installation and maintenance of pipeline systems. This is of advantage to petroleum processors, chemical producers, and other industries in which pipelines frequently are disassembled for cleaning or maintenance. *Clayton Mark & Company.*

Circle number (66) on reply card.

Submersible Sump Pump

Dynasump is first submersible sump pump to use sealless canned construction in which pump and motor are combined in a single leakproof unit. Pump is 9½ in. high, 5½ in. in diameter, and weighs only 8 lb. *Fostoria Corporation.*

Circle number (67) on reply card.

Temperature-Pressure Monitor

New digital system reads out combinations of both temperature and pressure. Is capable of remote interrogation because information is encoded for telemetering. Cost reduction is significant, since copper wiring to transducers is used instead of more expensive thermocouple wiring. *Geosciences & Instrumentation Division, Texas Instruments Incorporated.*

Circle number (68) on reply card.

. . . one of a series presented by Western Supply Company, Tulsa, to improve the "I.Q."* of engineers . . .
(*"Income Quotient")

Communicating your convictions gains better understanding, improved relations, greater results for engineers

Breathes there a man with soul so dead, who never to his friend has said, "Don't those lamebrains in the_____ Department every get ANYTHING right? . . . I very carefully wrote EVERYTHING down, very logically and clearly . . . didn't leave a thing out . . . and they still don't get my point!" — or words to that effect?

The only qualification you need for having voiced these sentiments is that you occupy yourself daily with one or more **people**, because it is with **people** that communications break down — people on either end of the chain of communication, whether they be employee or employer, buyer or seller, veteran or newcomer. **(See Footnote)**

Whether it be an internal or external message, verbal or written, a telephone message or a memorandum, a formal report or a business letter, technical or elementary, a progress report or a comparative, scientific analysis, the ground-rules are the same for successful communications.

Take our friend who is beset by "those lamebrains," for instance. Can he be so positive that it was the **other** end of the chain that bogged down? Perhaps he was **too complete** in his instructions, where simplicity would have sufficed. Perhaps the receiver merely needed short, concise directions, not the logical, careful rationalization of the writer. Perhaps his memorandum was clear to **him**, but maybe the "practical examples" he gave weren't so practical to the recipient because it was **outside his frame of reference**, background or experience. Maybe a telephone call would have been a more efficient medium of exchange in this instance.

The basic problem, then, is one of needing to transmit our beliefs, decisions, conclusions from us to someone else, and to have that other person **understand what we mean** — quickly, accurately, simply and — pleasantly.

Perhaps one of the cardinal rules for better communications, then, is **better understanding**: consideration for others, and a **desire** to understand another's viewpoint. Actually, this merely bespeaks the real origin of "fluid communications": **thought**, for thought plays a vital role in what we feel, observe, write, say, or demonstrate; and these **are** the principal means of communication available to everyone: thinking, feeling, observing, writing, saying, demonstrating. **(See Footnote)**

Does this sound like a monumental, life-long task? It is, and it isn't. It is **not** monumental unless you make it so by resenting it, and it **is** life-long, because as you change, as others change, as business changes, so do communication forms, vocabularies, meanings, frames of reference.

It is not sufficient in a competitive economy to **have** convictions; it is necessary to **sell** your convictions to someone who can either do something with them, or authorize you to do so. This, then is one of the chief values of communications; to help you accomplish your aims in engineering, in your professional life, more quickly, more productively, more successfully. Combined with your technical knowledge, your ability to perform and deliver, and your initative, communications can become the most valuable tool in your professional "workshop."

FOOTNOTE: For more detailed information on this subject, write for "Fluid, Fluent Communications," to WESTERN SUPPLY COMPANY, HEAT EXCHANGER DIVISION, P. O. BOX 1888, TULSA, OKLA. — and if there's a heat exchanger in your company's future, we'd appreciate a "line of communication" from you!

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

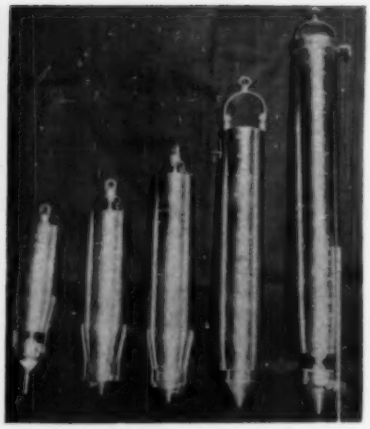
SKINNER·SEAL
PIPE JOINT CLAMP STOPS LEAKS
at joint where pipe is screwed into fitting

SKINNER·SEAL
PIPE JOINT CLAMP stops leaks at joints where pipe is screwed into fitting. Any temperature—any pressure up to 2,000 pounds. Saves the cost of tearing out and renewing leaky fittings. Prevents shutdowns. In stock at most oil supply stores.

SKINNER·SEAL
EMERGENCY PIPE CLAMPS for safe, sure, lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12" for steel and C.I. pipe. Stocked by practically all oil supply stores.

Complete line of Repair Clamps. Send for Catalog 54!

M. B. SKINNER CO.
SOUTH BEND 21, INDIANA



Tank Samplers

New Peterson tank sampler gages tank and obtains tank sample in one operation. Centerless shaft model for taking specific gravity is also available. It can be ordered with trip rod mounted either inside or outside. *P & M Manufacturing Company, Inc.*

Circle number (69) on reply card.

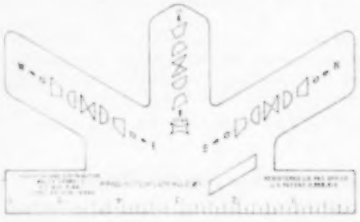
Electro-Pneumatic Transducer

Freeze-ups caused by cold weather or low-temperature fluids can be eliminated with the Type P2R Power Relay, a new electro-pneumatic transducer that permits a pneumatic valve actuator to be used with an electronic control system. Unit contains a 30-watt heater in the pneumatic section that prevents moisture in the air from freezing the mechanism. *Swartwout Division of the Crane Co.*

Circle number (70) on reply card.

Piping Iso-Template Rule

New template patented by a graduate engineer enables a standardized isometric drawing to be made of all pipe layout sketches. Even beginners can make professional drawings the first time with this



simple instrument. Other features include pocket size cut-outs for most common fitting symbols, laminated clear heavy-grade plastic, rounded corners for uniform angles, and handy compass orientation points. *Wally Verrett.*

Circle number (71) on reply card.

Closed Circuit TV Camera

Type TE-9-A, a self-contained, single-unit transistorized camera, is designed to function at top efficiency under extreme conditions of vibration and noise. Unit is cylindrical design, is 11¾ in. long and has diameter of 5½ in., and weighs only 9 lb. *General Electric Communication Products Dept.*

Circle number (72) on reply card.

6-ft Stem Thermometer

Measuring temperatures in deep vats, kettles, tanks, stacks, ovens, ducts, and other vessels is easy with 6-ft stem thermometer, accurate within 1 percent of full scale reading. Available in temperature ranges from 0 to 200 and 200 to 1000 F. Also supplied in centigrade calibrations. *W. C. Dillon & Co., Inc.*

Circle number (73) on reply card.

Solenoid Valves

Three-position, 4-way solenoid valves are suitable for handling air, water, and oil from 10 to 250 psi on a-c or d-c voltages. They are supplied with rugged brass bar stock body and poppet type seats and are available with ¼ or ⅜-in. pipe connections. *Automatic Switch Company.*

Circle number (74) on reply card.

Instant Adding

All the 183,000 multi-digit figures in these yards of adding machine tape can be added in one second by the new RCA 601 electronic data processing system,

claimed to be the world's fastest business computer. System can recall any fact or figure from its "memory" in 1½ millionths of a second. *Radio Corporation of America.*

Circle number (75) on reply card.

Weldment-Type Flow Tubes

New weldment-type Dall flow tubes have been developed for metering petroleum, chemical, gases, or other process fluids at low or high pressures and temperatures. Thus the combined advantages of power savings from low head loss, maximum accuracy, and short laying length can be offered in metals proved best for a specific flow metering application. *B-I-F Industries, Inc.*

Circle number (76) on reply card.

Chloride Ion Analyzer

Chloride ion analyzer continuously and automatically determines the chloride ion concentration in aqueous solutions over a range of from 0.1 to 10,000 parts per million. Chloride ion measurements are read directly from the instrument meter or from a conventional potentiometric recorder. *Scientific and Process Instruments Division, Beckman Instruments, Inc.*

Circle number (77) on reply card.

PETRO/CHEM

news makers

▸ **Maurice E. Brooks, George R. Collins,** and **Ralph E. Wise** have been elected vice presidents of The Lummus Co., worldwide industrial engineers and constructors. The three men are, respectively, director of engineering, director of construction, and vice president of The Lummus Co. Canada Ltd.

▸ Arthur G. McKee and Co., Cleveland, announces election of **William B. Hudson, Jr.,** as vice president in charge of refinery engineering and appointment of **Edwin G. Graeber** as technical director in charge of process engineering. Hudson formerly was associated with Foster Wheeler Corp. in various technical and executive positions, while Graeber was chief process engineer of Air Reduction Co., Inc.

E. G. Graeber

W. B. Hudson

▸ Certificates of appreciation for service to the API and the oil industry were presented to **John T. McCoy,** New York, coordinator of Tidewater Oil Co.'s eastern division manufacturing department, and **John W. Newton,** Beaumont, Tex., president of Norvell Wilder Supply Co., at the 25th midyear meeting of the API's Division of Refining in Detroit in May.

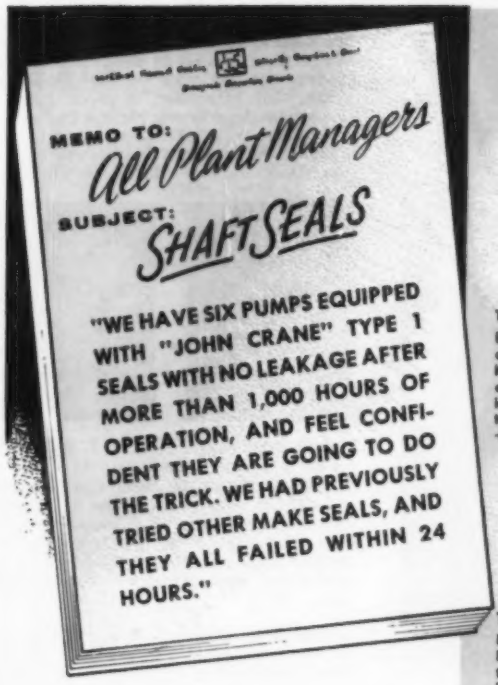
▸ **Edward S. Fraser** has been elected vice president - manufacturing of Chicago Bridge & Iron Co., world-wide plate fabricating and construction firm.

▸ **James R. Bowden,** Ponca City, Okla., research group leader in Continental Oil Co.'s research and development department, has been awarded a 1960-61 Sloan Fellowship at Massachusetts Institute of Technology.

▸ A series of organizational changes have been announced in the Petroleum Chemicals Division of E. I. du Pont de Nemours & Co.

William T. Robinson, head of the products application and service division at the petroleum laboratory, Deepwater Point, N. J., has been transferred to the Wilmington office as technical assistant. His successor is **Robert O. Braendle,** technical manager of the eastern region with headquarters in New York. Successor to Braendle is **George A. Finn,** assistant technical manager of the eastern region.

J. Brent Malin, technical manager of the western region has been named to the newly created position of head of the technical information division. **Anton O. Melby,** technical assistant of new product development, assumes Malin's former post.


MEMO TO:
All Plant Managers
SUBJECT:
SHAFT SEALS
"WE HAVE SIX PUMPS EQUIPPED WITH "JOHN CRANE" TYPE 1 SEALS WITH NO LEAKAGE AFTER MORE THAN 1,000 HOURS OF OPERATION, AND FEEL CONFIDENT THEY ARE GOING TO DO THE TRICK. WE HAD PREVIOUSLY TRIED OTHER MAKE SEALS, AND THEY ALL FAILED WITHIN 24 HOURS."

This is part of an actual memo sent by one plant manager to others of the same company in different sections of the country—and that company is now exclusively specifying these and other type "John Crane" Shaft Seals for *all* their liquid handling requirements.

You too can save time, trouble and expense by doing likewise.

You'll find a "John Crane" Shaft Seal for every service . . . from hot or cold water to the most destructive acids and corrosives . . . high temperatures, high pressures . . . in types and sizes to meet practically any mechanical or dimensional requirement.

Send us details on your application. We'll recommend the proper shaft seal. Request Bulletin S-204-3 for complete overall information.

Crane Packing Co., 6486 Oakton St., Morton Grove, Illinois, (Chicago Suburb).

In Canada: Crane Packing Company, Ltd., Hamilton, Ont.

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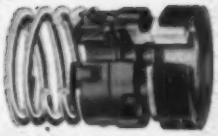
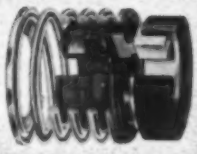


TYPE 1
Designed for limited stuffing box diameter. Handles water, light hydrocarbons, refrigerants, mild acids and other liquids noninjurious to synthetic rubber at temperatures from −40°F. to +212°F., pressures to 200 psi.



TYPE 2
Designed for limited stuffing box length. Handles same services, temperatures and pressures as Type 1.

TYPE 8-B
Heavy duty, high pressures. Packaged construction for easy installation. Handles pressures to 1200 psi., temperatures from −40°F. to +250°F. Services same as Type 1.

TYPE 9
Famous as a problem solver. Sealing members of chemically inert Du Pont Teflon. Engineered to service conditions to handle practically all destructive acids, corrosives and gases at temperatures from −120°F. to +500°F., pressures to 150 psi. Available in balanced construction for pressures to 750 psi.

We've got the right size in SOLVAY ALUMINUM CHLORIDE

Coarse screened. Medium screened. Fine screened. Extra fine grind. Which grade fits your needs?

Solvay® Aluminum Chloride is 99.5% pure or better. Meets rigid chemical specifications. Used for producing detergent intermediates and other alkylates . . . isomerization . . . polymerization . . . varied Friedel-Crafts syntheses.

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▸ The Hanlon Award, highest honor in the natural gasoline industry and one of the ranking awards of the petroleum industry, was conferred on **Karl H. Hachmuth,** staff consultant, research and development department, Phillips Petroleum Co., Bartlesville, Okla., during the 39th annual convention of the Natural Gasoline Association of America in Houston.

K. H. Hachmuth

A. T. Knight

▸ **Alan T. Knight** has been elected president of Catalytic Construction Co., Philadelphia, succeeding T. Ellwood Webster who died April 1. Knight, a vice president since the company was formed in 1946, had been executive vice president since 1953.

▸ **Walter A. Anderson,** resident manager of Procon (Canada) Ltd., has been elected a vice president of the refinery and chemical plant construction company.

▸ **J. J. Dvorak** has been promoted to assistant division head in technical division at Humble Oil & Refining Co.'s Baytown, Tex., refinery and now directs efforts of the central engineering branch.

▸ **William L. Sheets,** vice president of Stone & Webster Engineering Corp., has been named senior construction manager of the worldwide engineering and construction organization and will be responsible for administrative direction of all construction department activities.

W. L. Sheets

F. H. Ramseur

▸ **Fred H. Ramseur, Jr.,** has been named manager of the gasoline division of Cities Service Oil Co. (Del.), and elected a director of the company. He succeeds **Frank M. Perry,** who has been elected president and general manager of Petroleum Chemicals, Inc., headquartered in New Orleans and jointly owned by Cities Service and Continental Oil Co. Ramseur, who will be based in Bartlesville, Okla., was coordinator of light hydrocarbons for Cities Service Petroleum, Inc., in New York.

Bruce K. Brown, New Orleans, president of Petroleum Chemicals, Inc., since 1956, has been elected chairman of the board and chief executive officer of the firm.

▸ Whiting research laboratories of Standard Oil Co. (Ind.) announce appointment of **Hal M. Hart** as a project director and **Jack M. Paul** as a group leader.

▸ **Dr. Ferdinand B. Zienty** is director and **Drs. Harold R. Gamrath, Robert E. Howard, Ralph H. Munch,** and **Oliver J. Weinkauff** have been appointed research associates in the new department of advanced organic chemicals research established within the research department of Monsanto Chemical Co.'s organic chemicals division, St. Louis.

Other Monsanto appointments include **Drs. Richard S. Gordon** and **Martin W. Farrar,** assistant directors of research; **Dr. Oliver DeGarmo,** director of intermediates and fine chemicals research; **Harold L. Hubbard,** director of engineering research and physical chemistry, and **Harry W. Faust,** manager of staff services for the research department.

▸ New president of Girdler Construction Corporation, Louisville, Ky., is **Alexander Kidd.** Kidd, who was vice president of Stewart-Warner Corp., Chicago, succeeds **W. Roberts Wood,** who has resigned to devote full time to his duties as a vice president of Chemetron Corp., Chicago.

▸ **Robert B. Costello** has been appointed operations manager of the Buenos Aires, Argentina office of Kellogg Pan American Corp. and will be responsible for the engineering, procurement, and construction activities of Kellogg Pan American Corp. in Argentina.

▸ Recent appointments at California Research Corp.'s Richmond laboratory include those of **Dr. H. F. Harnsberger** as supervising research chemist, petroleum process research section, and **V. C. Davis** as supervising research engineer, instrument development and maintenance, general services division.

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SEALING COMPOUNDS

Heat and vibration-proof, non-solvent, will not shrink, crack or crumble. Makes all assemblies leak-proof and pressure-tight. Prevents rust, corrosion and joint seizure.

7 BASIC BLENDS

LIQUID WRENCH

LOOSENS RUSTED BOLTS

A powerful blend of fast-acting solvents that literally "melt the rust away"—safe on all metals and alloys.

RADIATOR SPECIALTY CO.
CHARLOTTE, N. C.

PETRO/CHEM processing parade

Appointments:

Claude B. Nolte, head of new advance product planning and research program, Barton Instrument Corporation.

George A. Green, product planning manager, Scientific and Process Instruments Division, Beckman Instruments Inc.

Robert M. Lewison, manager, International Division, Fischer & Porter Company.

Henry D. Rolph, special assistant to the president, Rockwell Manufacturing Company; responsible for coordinating activities of Rockwell's German operations.

Robert O. Vaughan, vice president, marketing, Southwestern Industrial Electronics, one of the Dresser Industries.

James E. McDonald, manager, mechanical and pressure tubing products, National Tube Division, United States Steel Corporation.

John L. Young, vice president-engineering technology, United States Steel.

Joseph A. Wiendl, general manager of sales, Ingersoll-Rand Co.

Glen R. Pierce, manager, distributor-sales division, Dearborn Chemical Co., Chicago.

Blaine B. Kuist, vice president, for engineering and construction, Chemical Division, Rexall Drug and Chemical Company.

George S. Leachman, Southwest district manager, Nitrogen Division, Allied Chemical Corporation, based in Dallas.

Earl B. Marrs, manager of Tulsa office, Midwest Piping Company, Inc., for sales in Oklahoma, Arkansas, and Northwest and West Texas.

A. J. Smith, in charge of New York office, Constructors John Brown Ltd. of London.

H. F. Detrick, vice president in charge, capital equipment group (formerly the petroleum group); **Thomas H. Creden,** general manager, tubular division; **Warren Hendricksen,** general manager, atomic and process equipment division; **H. D. Barnes,** general manager, space-ordnance division, A. O. Smith Corp.

Walter J. Blair, vertical pump product sales manager, Peerless Pump, Hydrodynamics division, Food Machinery and Chemical Corp.

Dr. Michael Erchak, Jr., vice president for research and development, Chemical Division, Rexall Drug and Chemical Company.

Don B. Bramley, sales engineer, Cooper-Bessemer Corp., Mount Vernon, Ohio.

Lincoln D. Hall, manager, midwest district, Tube Turns division, Chemetron Corp., with headquarters in Kansas City.

Hamilton Hadden, Jr., vice president and general manager; **Ivan Bollinger,** director of export sales; **Gregory Marames,** manager of export traffic, new foreign operations division, Chemstrand Corp.

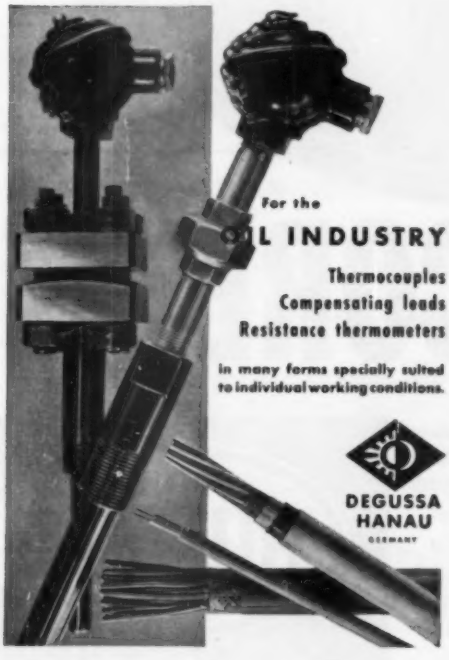
Jack L. Duke, sales representative for gas turbine engines and turbomachinery products in Houston, Solar Aircraft Co.

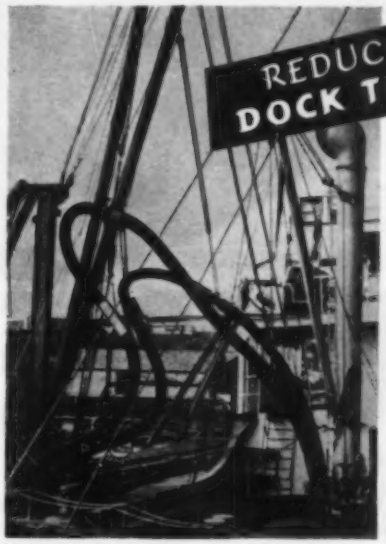
O. F. Henning, marketing manager, Texas Instruments Incorporated Geosciences & Instrumentation division's instrumentation product group, Houston.

William A. Roever, manager, new Dallas district office, Clark Bros. Co.

J. D. Rollins, vice president-facility planning and appropriations, United States Steel.

James C. Tucker, manager, Frankfurt, Germany, marketing office; **Roger R. Zoccolillo,** manager, Milan, Italy, marketing office, Dow Chemical International Limited S.A.





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- Hycar Tube—High-Octane Resistant
- Uniform Bore Assures Rapid Flow—Suction and Discharge
- Oil, Abrasion and Weather Resisting Neoprene Cover
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- 7 Types for Pressures to 200 psi.

Paranite Loading Hose for years has been recognized for long service.

Furnished in 7 types, smooth-bore, rough bore, for sea and dock ship loading and for barge service.

Ask about R/M Rotary Hose, Mud Pump Intake Hose, Vibration Hose, and Non-Bursting Steam Hose.

RM 1047

RAYBESTOS-MANHATTAN, INC.
MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY
ENGINEERED RUBBER PRODUCTS.. MORE USE PER DOLLAR

*Practically Perfect!

HUMBLE COREXIT

Save time and money previously lost to internal corrosion: use Humble COREXIT . . . COREXIT effectively and economically prevents internal corrosion in pipe still overhead, distillation towers, vapor recovery systems and other refining units. COREXIT will reduce or completely eliminate plugging or fouling. This protection against sludge, scale and corrosion cuts non-productive downtime to a minimum. For complete information on technical services and products, contact your Humble salesman.

HUMBLE

HUMBLE OIL & REFINING COMPANY

PROTECTION *is our business*

Quality Control – From PIT (Our Asbestos Mines) *To* PIPE (Yours) *– Insures To Each Type of Nicolet Asbestos Pipe Line Felt Uniformity In Performance Characteristic And Quality.*

From the moment the raw Asbestos comes out of the Nicolet Asbestos Mines until the Asbestos Felt is shipped to you, care in manufacture and rigid inspection throughout are maintained to give you the finest Asbestos Pipe Line Felts obtainable.

This is the main reason more and more Corrosion Engineers are specifying Nicolet Asbestos Pipe Line Felts with complete confidence. Whether they need Nicolet #15 "Standard", #8 "Tufbestos" or #10 "Reflecto" (the new, improved, white Asbestos Felt) they know they will be providing the best possible pipe line protection.

And now — the addition of "Old Nic" Glass Wrap to the Nicolet line of pipe wrap products makes Nicolet their best source for complete protection — and makes it yours, too.

Write today for complete specifications and samples of Nicolet Pipe Line Products.

Nicolet Industries, Inc.
Florham Park, New Jersey

O.K., send me samples and specifications of:

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now... longer life, improved performance for pipelines, crude units... with Unicor

Are you aware of the tremendous difference a small amount of Unicor can make in pipelines and crude units?

This film-forming, oil-soluble inhibitor prevents all kinds of corrosion. Wherever Unicor has plated out on a surface, it gives protection to tanks, vessels and pipelines whether full, part-full or empty.

By adding a small amount of Unicor to your product—10-20 parts to a million—you prevent product contamination, profit-robbing corrosion; assure maintenance of full-flow capacity and output.

Furthermore, use of Unicor substantially reduces filter cleaning and replacements, scraping operations, power costs and expensive downtime.

What Unicor does for tanks and pipelines it also accomplishes in crude units and other refinery equipment. For detailed information, write to our Products Department.

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UNICOR®

SHAPING THE FUTURE
. . . in Pipelining

PIPELINE EASEMENTS ARE SUBJECT TO DEPRECIATION DEDUCTIONS, the Eighth Circuit Court of Appeals has ruled, reversing a decision of a Federal Court. Maintaining that purchased rights-of-way were for an indeterminate period, and so, like land, not depreciable, the Revenue Service disallowed certain claims by Northern Natural Gas Company. Northern argued that easements were limited by the amount of gas reserves available for transmission and thus depreciable. This contention eventually was upheld.

THE TREND OF GAS TRANSMISSION PIPELINES to branch out into the field of petrochemicals is further indicated by announcement of a joint venture by El Paso Natural Gas Company and Rexall Drug and Chemical Company. Several plants will be built, the first at Odessa, Texas, to go onstream early in 1962. Products will include ethylene, propylene, conventional polyethylene, linear polyethylene, polypropylene, olefins, and polyolefins.

THE U. S. SUPREME COURT WILL REVIEW a lower court's ruling that overturned the FPC order prohibiting Transcontinental Gas Pipe Line from transporting gas for Consolidated Edison Company. Con-Ed purchased gas in the field to use as boiler fuel. Transco was to be the transportation medium. FPC said no, a Third Circuit Court reversed this, now the Supreme Court will decide. The outcome is important. It could be a means of avoiding federal control over gas purchases. Equally important is the aspect of FPC control over end use of gas.

GREATER USE OF POLYETHYLENE PIPE in low pressure gas gathering systems has been predicted, representing a large new end product for natural gas raw materials. Leo B. Croley, Phillips Petroleum Company, told members of the Natural Gasoline Association of America recently that 1000 miles of such gathering lines would be laid during the next 12 months. High density polyethylene pipe could be used for this service, he said.

A NEW ISSUE HAS BEEN INJECTED INTO GAS FIELD PRICE REGULATION. The issue is, does the Federal Power Commission have the right to ignore rights of royalty owners in making its decisions? This question has arisen from protest of the Navajo Indians as result of FPC's refusal to hold a rehearing on its order to reduce the price of Aneth gas from 20 cents to 17.7 cents per Mcf. Request that the Indian interest be considered was made in letter form and not as a formal application, said FPC, and therefore had no official standing.

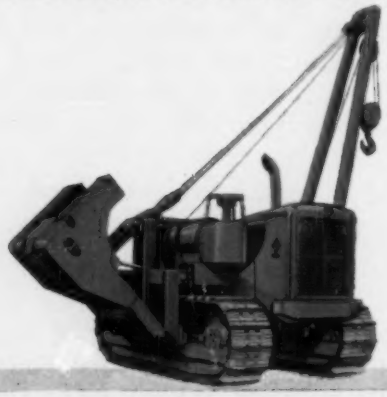
MIGHTY... HEALTHY... POWER

Whether your choice is the 225-hp HD-21 or the 150-hp HD-16, you get from 8½% to 27% more efficient engine operation than from other crawlers.

This fuel-pinching efficiency is a fact! Your Allis-Chalmers dealer will show you actual proof of up to 27% fuel savings in the Allis-Chalmers 16000 or 21000 engines over units of comparable size. He'll tell you why they run cleaner . . . how they "sip" fuel to earn the title "industry's healthiest engines."

Six crater-shaped pistons develop 225 hp in the HD-21, 150 hp in the HD-16 . . . both at an easy 1825 rpm. Coupled with torque converter drive, they provide plenty of rough dozing lugability . . . plenty of side boom liftability.

These big Allis-Chalmers tractors are built for mighty tough service . . . right-of-way pioneering, stringing, cradling, or lowering-in. Shock-absorbing all-steel main frame, durable double-reduction final drives, certified permanent lubrication of tapered roller bearing truck wheels, idlers and rollers, and extra tough track keep them going season after season with a minimum of maintenance. Your Allis-Chalmers construction machinery dealer will be glad to show you an HD-21 or HD-16 soon. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.



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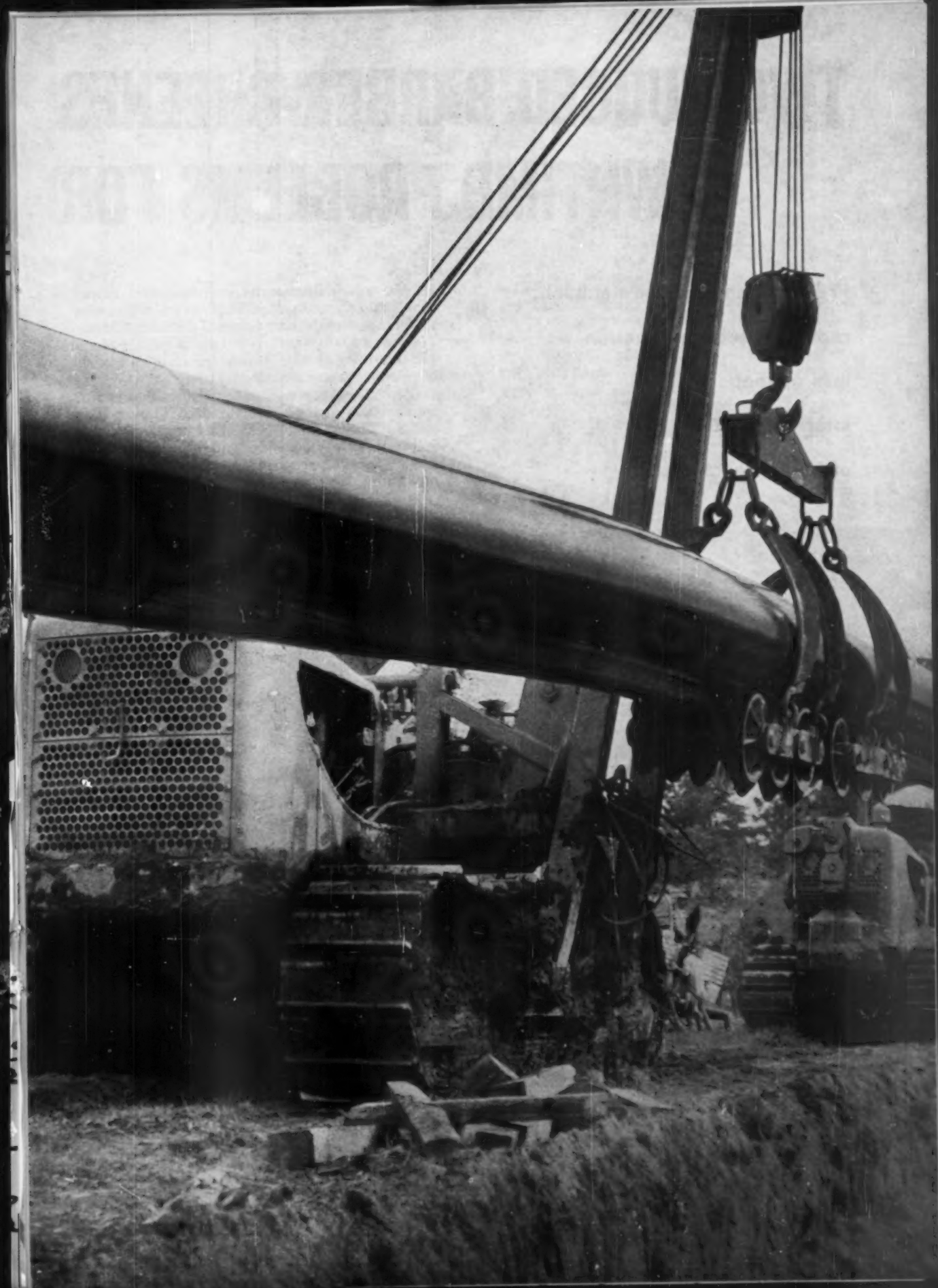
ALLIS-CHALMERS

power for a growing world



TWO RUGGED BARBER-GREENES DOWNTIME PROBLEMS FOR

President and master mechanic report steadier production, less upkeep after 1,400,000-ft of tough trenching...

Excessive maintenance and downtime were stopped cold by the Ohio Pipeline Co., Newark, Ohio, after switching to two Barber-Greene Ditchers—a Model 774 with a 1,000,000-ft record and a smaller Model 772 that totalled 400,000-ft of trench in six months of practically continuous operation.

Oscar Ralston, president of this firm that installs transmission and distribution lines all over Ohio, states: "Both machines have performed very satisfactorily. Dual-range Hydra-Crowd transmission lets our operators keep machines operating at their maximum capacity, regardless of changing soil

LICK MAINTENANCE AND OHIO PIPELINE COMPANY

conditions. There's never any radical step-down in forward speed to compensate for tougher digging conditions as is the case with mechanical transmission ditchers."

Master Mechanic Ben Rhodes adds: "On competitive ditchers we've owned, we had plenty of maintenance problems... particularly on discharge conveyors. There were lots of chain, sprocket and idler replacements plus downtime due to chain breakage. We have virtually eliminated this with Barber-Greene hydraulic drives. Maintenance has been mighty low on both ditchers."

See why your Barber-Greene Distributor sells the only modern ditcher line by visiting a job with him. You'll know why owners report from 25-200% more production when you see Hydra-Crowd and these additional features in action: Flexible drawbar between chassis and boom; all-hydraulic spoil conveyor independent of wheel speeds; hydraulic controls for greater line-and-grade holding accuracy; automatic overload protection; and crawler adjustments 10 times faster than on ordinary ditchers.

This 5½-ft Model 774 has won praise of Ohio Pipeline's president, the master mechanic and the operator in digging 1,000,000-ft of trench in 18 months. Can be equipped with 7-ft wheel for 50% less than any other wheel ditcher with this depth capacity.

Ohio Pipeline's Model 772 has narrow track gauge enabling it to work within 19-in. of side obstructions. Trenches 10-24-in. wide and to 5½-ft depths. Model 773 is identical except for wider track gauge and pad width.

Crawler or rubber-tired Barber-Greene Vertical Boom Ditchers cut low cost trench from 5½ to 24-in. wide and to 7-ft deep. Model 784 is shown.

Manufacturer of the only modern ditcher line

Representatives in Principal Cities of the World

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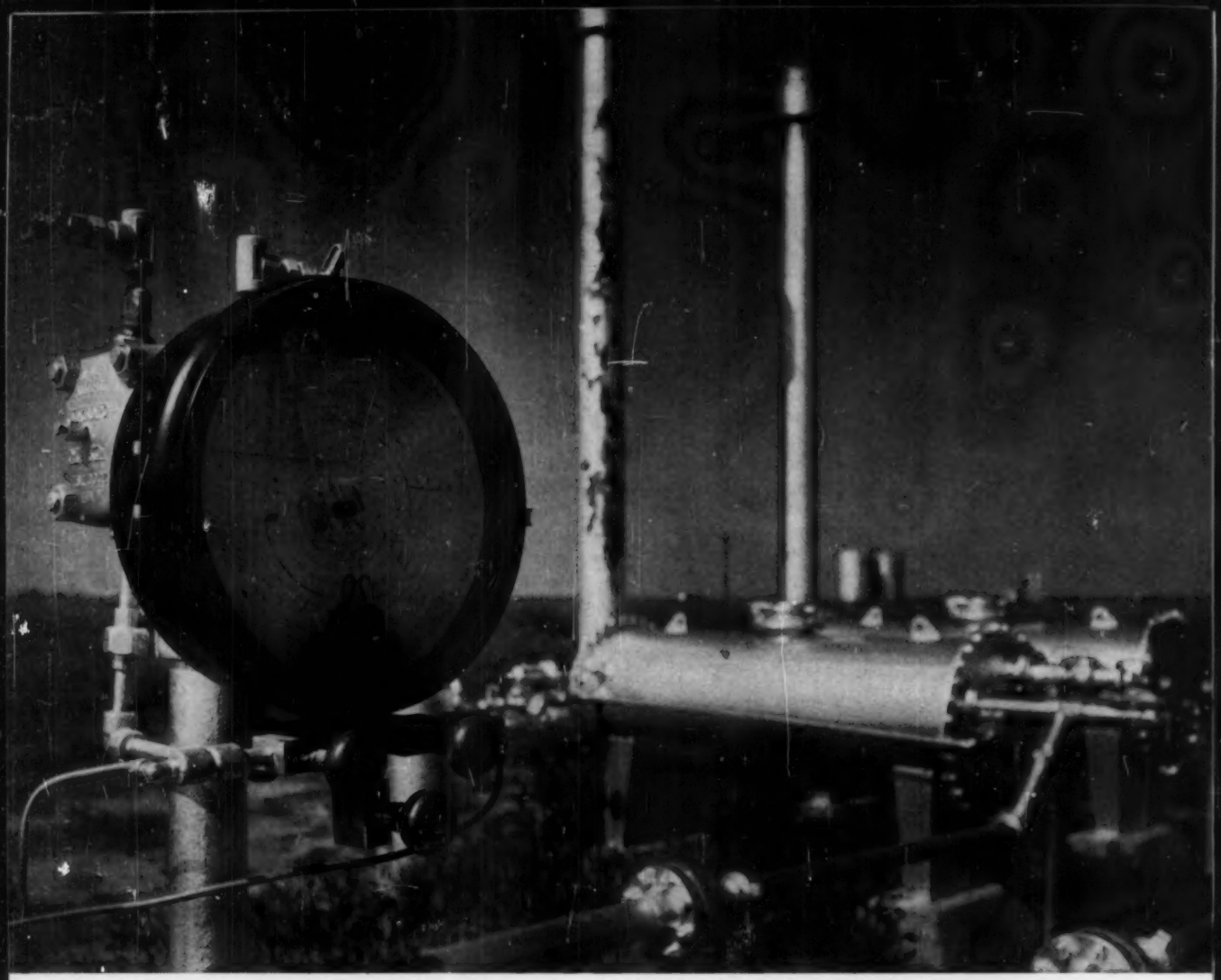
CONVEYORS • LOADERS • DITCHERS • ASPHALT PAVING EQUIPMENT



One of the 11 Foxboro T/37 Diaphragm Flow Meters, measuring wet gas to separators, at W. L. Pickens' North LaWard Field, Jackson County, Texas.

"Wet gas can't foul it... overrange can't hurt it... and it doesn't need maintenance"

THE FOXBORO T/37 DIAPHRAGM FLOW METER

"Undoubtedly the most reliable flow meter we've ever used." That's the report on the 11 Foxboro Diaphragm Flow Meters at W. L. Pickens' North LaWard Field in Jackson County, Texas.

Walter B. Hollow, Drilling and Production Superintendent, states that even though these meters have been in service over a year, none have ever needed re-calibration.

"The Foxboro Diaphragm Meter also eliminates a problem we had of mercury being lost on sudden overranges caused by line surges," Mr. Hollow adds. "And of course, our weekly chore of draining mercury to remove water is a thing of the past."

Producers, pipeliners, plant men — they're all praising this outstanding Foxboro flow meter. Get the complete story on the T/37 in Bulletin 7-15. Or ask your nearby Foxboro Field Engineer. **The Foxboro Company, 386 Norfolk Street, Foxboro, Massachusetts.**

Specially-formed diaphragm discs and solid metal spacer rings insure the T/37 Diaphragm Meter from overrange damage. Spacer rings also protect diaphragm assembly from rupture or distortion by dirt particles — or hyrdates formed in moisture of gas lines.

FOXBORO
REG. U.S. PAT. OFF.

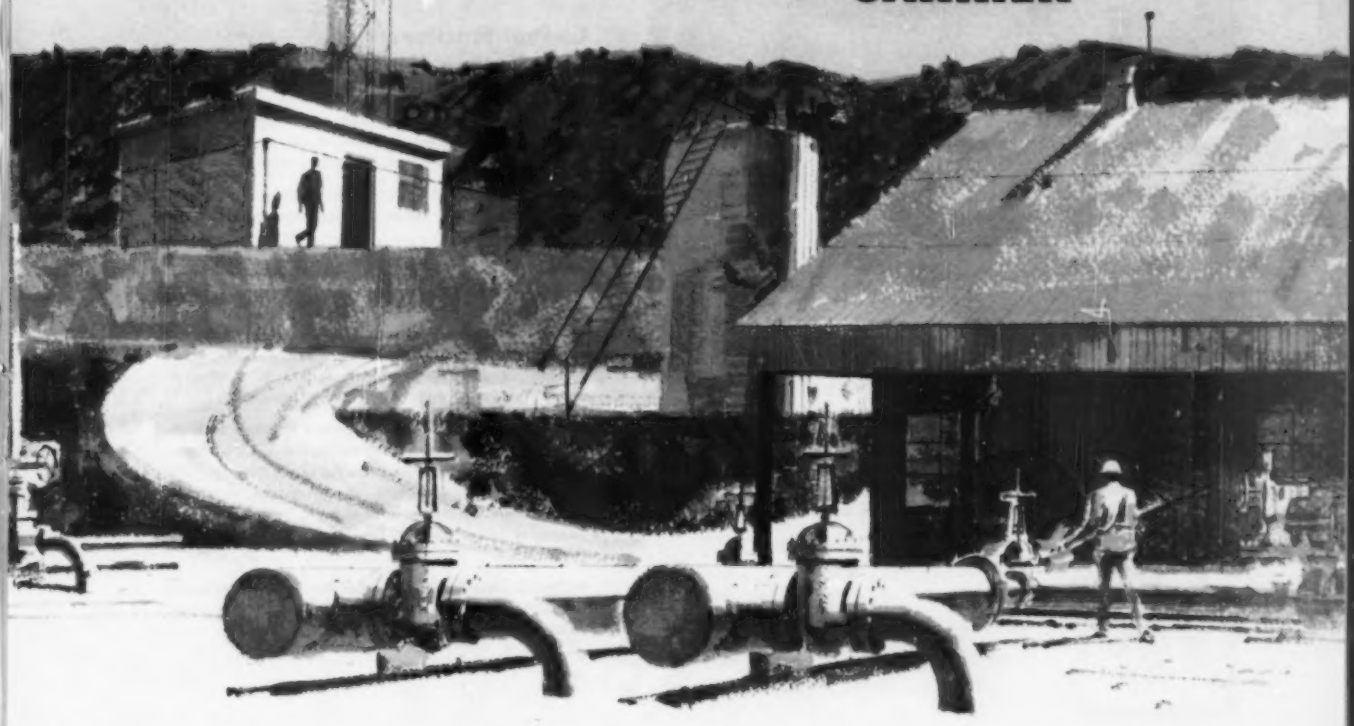
FIRST IN FLOW METERING

TEXAS-NEW MEXICO PIPE LINE COMPANY

installs microwave for control and monitoring of 513-mile pipeline...

New 14-hop Collins microwave-carrier system extends from pipeline offices in Blanding, Utah, to terminal at Mesa, New Mexico. Initially, it provides eight voice channels plus two party-line control circuits and one party-line telegraph circuit. From the master control point at Aneth, Utah, microwave equipment can start and stop pumps at other stations, measure rate of flow from remote points, measure suction and discharge at booster stations and open or close distant valves. It also provides VHF communication with mobile units from any of four control points. For information on a microwave-carrier system tailored to your individual needs, contact Collins Radio Company, Texas Division Sales, 1200 No. Alma Rd., Richardson, Texas.

COLLINS MICROWAVE AND CARRIER



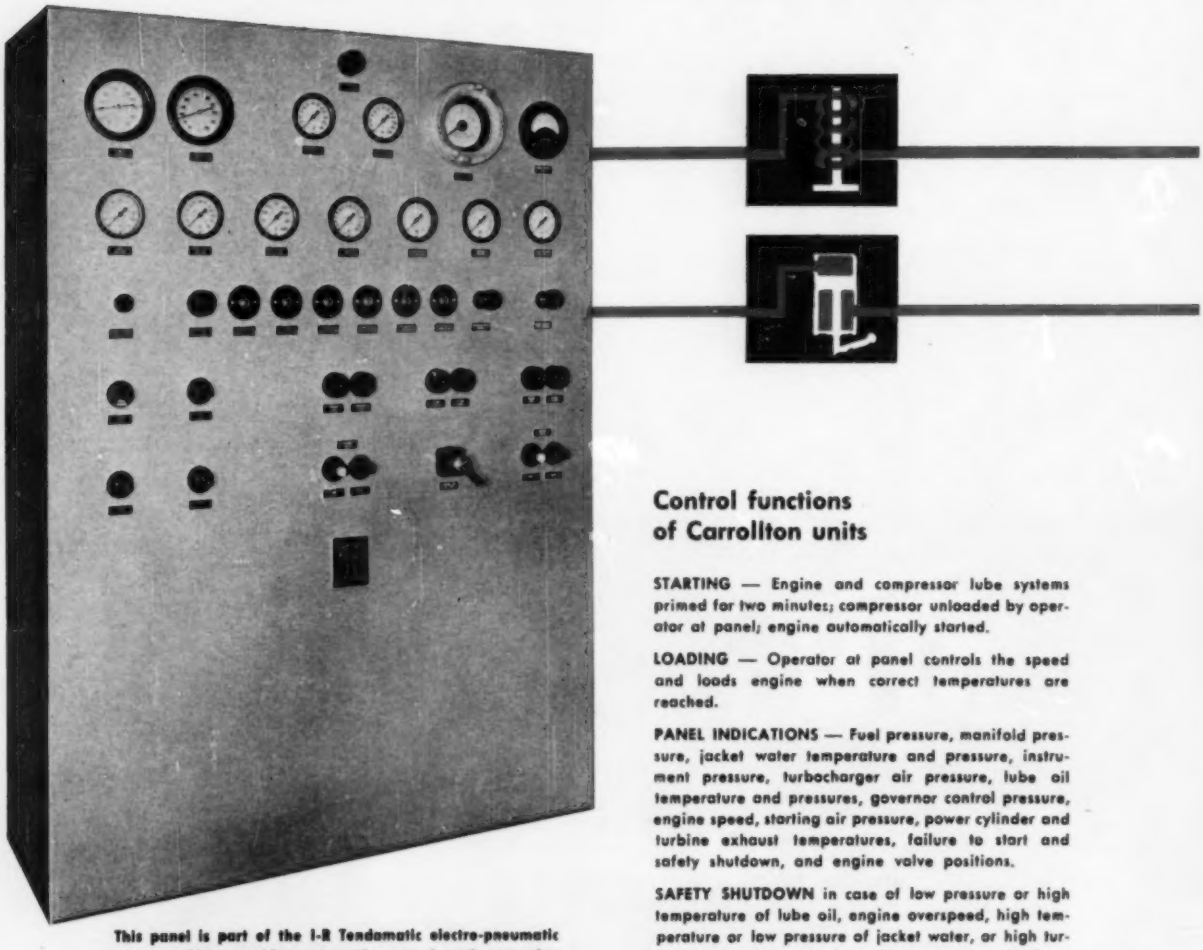
COLLINS

COLLINS RADIO COMPANY • DALLAS, TEXAS • CEDAR RAPIDS, IOWA • BURBANK, CALIFORNIA

AT TENNESSEE GAS

NEW Tendamatic

ELECTRO-PNEUMATIC



This panel is part of the I-R Tendamatic electro-pneumatic system which provides automatic control and protection of KVS gas-engine compressors at the Carrollton station.

Control functions of Carrollton units

STARTING — Engine and compressor lube systems primed for two minutes; compressor unloaded by operator at panel; engine automatically started.

LOADING — Operator at panel controls the speed and loads engine when correct temperatures are reached.

PANEL INDICATIONS — Fuel pressure, manifold pressure, jacket water temperature and pressure, instrument pressure, turbocharger air pressure, lube oil temperature and pressures, governor control pressure, engine speed, starting air pressure, power cylinder and turbine exhaust temperatures, failure to start and safety shutdown, and engine valve positions.

SAFETY SHUTDOWN in case of low pressure or high temperature of lube oil, engine overspeed, high temperature or low pressure of jacket water, or high turbine exhaust temperature. If emergency shutdown occurs, horn sounds and pneumatic indicators show reason at panel; fuel gas is shut off and later ignition is grounded.

NORMAL SHUTDOWN — Operator at panel actuates automatic sequence which unloads, slows and stops unit. Lube system runs for two minutes longer.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

PIPELINE COMPANY. . .

compressor control features

operation

for convenience and economy in starting and normal shutdown sequence control

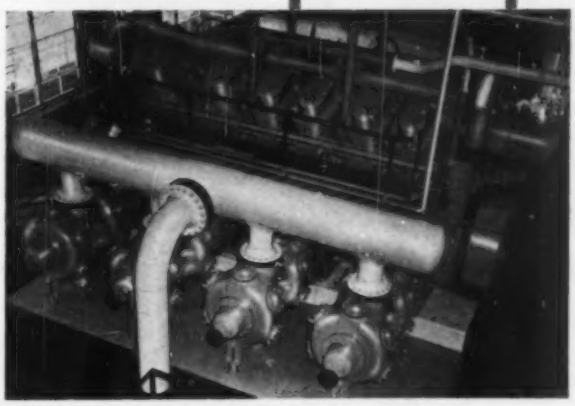
for safety and dependability in normal running and emergency shutdown control

At the Carrollton, Ohio, station of Tennessee Gas Pipeline Company, a division of Tennessee Gas Transmission Company, four 2000-hp Ingersoll-Rand KVS gas-engine compressors are operating under the constant vigil of a new achievement in automatic control systems.

This new I-R Tendamatic control installation combines the advantages of both electric and pneumatic operation in a single automatic control and protection system. Engine startup and normal shutdown are accomplished by electrical sequence control, permitting the use of compact electric timers, relays, etc. Once the compressor is loaded and on the line, the pneumatic system takes over the job of monitoring, indication and automatic emergency shutdown.

Therefore, the control and protection of the engine-compressors are independent of the electrical system, and a power failure would have no effect on successful operation.

Tendamatic systems can be supplied to meet any requirements — for remote, semi-remote, local, microwave, two-wire, multiple-wire, electric, pneumatic or hydraulic operation or in combinations. For more information, call your I-R representative.



Ingersoll-Rand 2000-hp KVS 4-cycle, V-angle engine-compressors at the TGP Carrollton station.

Only I-R compressors have Tendamatic control

Ingersoll-Rand

1A6 **11 Broadway, New York 4, N. Y.**

COMPRESSORS • PUMPS • AIR AND ELECTRICAL TOOLS • VACUUM EQUIPMENT • ROCK DRILLS • CONDENSERS • GAS AND DIESEL ENGINES

MUDDY GOING IN MOSCOW

Moscow, *Kentucky*, that is. That's where our photographer had the muddiest assignment of his career. But his problems were trifling compared to those of the men who had the job of laying 30-in. pipe for Trunkline Gas Company. For them, hipboots were standard dress. Fortunately, men and machines proved to be hardy "mudders," and the line went through.

The project was Panama, Inc.'s Spread Two, extending south from Clinton, Kentucky to the vicinity of Union City, Tennessee. Bethlehem Line Pipe was used on this and other spreads in Trunkline's current program, which calls for 895 miles of looping lines and an extension of their main line to the Michigan-Indiana border.

TRENCH OR DAM? Mud wasn't the pipeliners' only problem. Heavy rains soaked the earth, causing numerous cave-ins.

THAT'S MORE LIKE IT! The going was a lot smoother on this Trunkline spread near Leland, Mississippi. Here, too, both Panama, Inc., and Bethlehem pipe were on the job.

Bethlehem Line Pipe from ½ to 42 in. OD

Bethlehem supplies line pipe in all sizes, including continuous buttweld (½ in. through 4½ in.), electric resistance-weld (5⁹⁄₁₆ in. through 16 in.), and electric fusion-weld (18 in. through 42 in.). In the larger diameters, Bethlehem is now able to furnish walls up to ¾ in. thick.

Need line pipe? Just call our nearest sales office.

for strength
. . . economy
. . . versatility

Steel

THERE'S MUD IN ROME,—TOO! Rome, New York, that is. Pipeliners are shown here wrestling with Bethlehem 6⅝-in. OD electric resistance-weld pipe for Buckeye Pipe Line Company's jet fuel line to Griffiss Air Force Base.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

"We're getting 30% more production, cut fuel costs in half, reduced operating costs 15%... *all with the Gar Wood-Buckeye 318!"*

says D. D. Vaughn, General Manager, Vaughn & Taylor Construction Co., Odessa, Texas

"This is the best ditcher for pipeline work that I've ever handled—and I've been handling ditchers for 39 years.

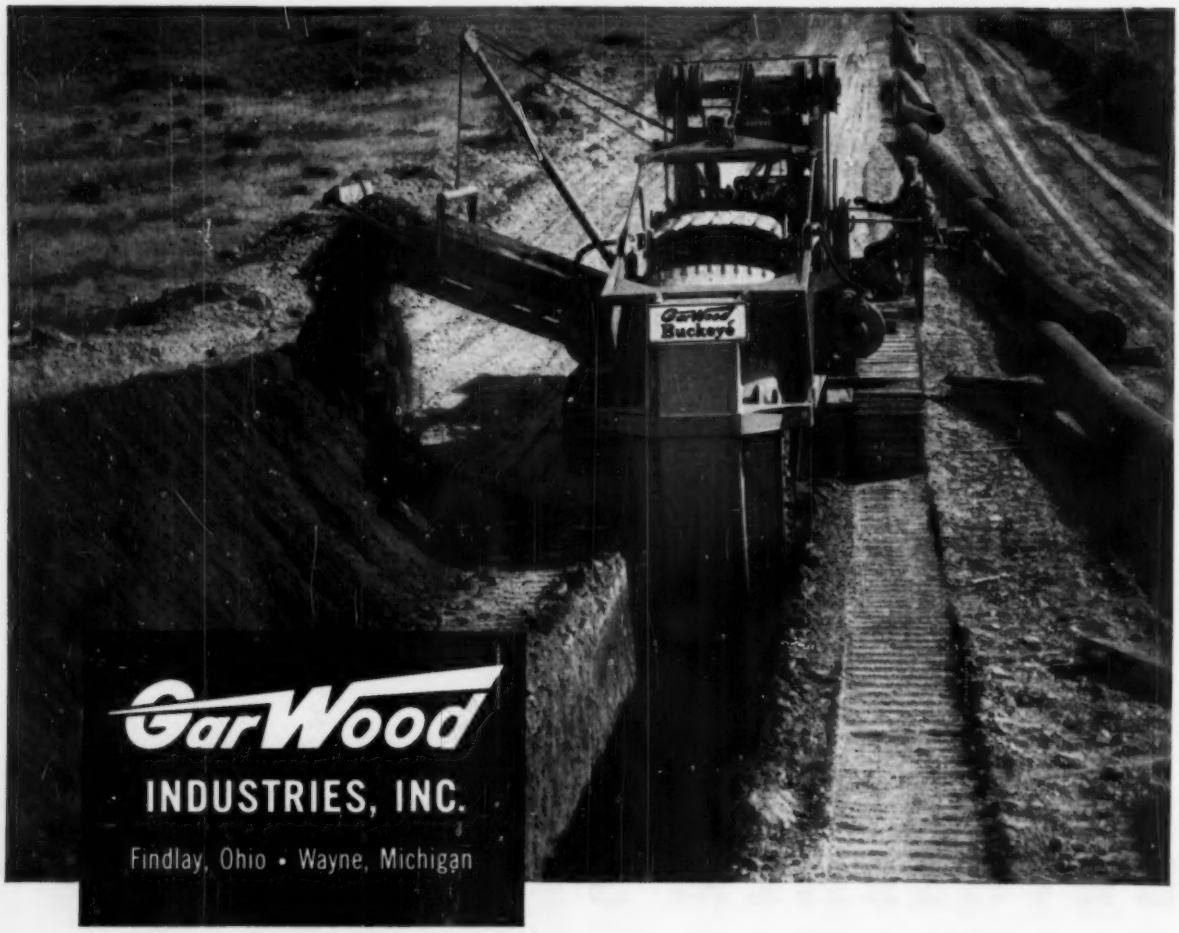
"We haven't had to touch a wrench to our 318, and already it's dug 40,000 feet of ditch and moved 32,000 cubic yards of dirt.

"There's no question about it—two 318's will do more work than any other three machines put together."

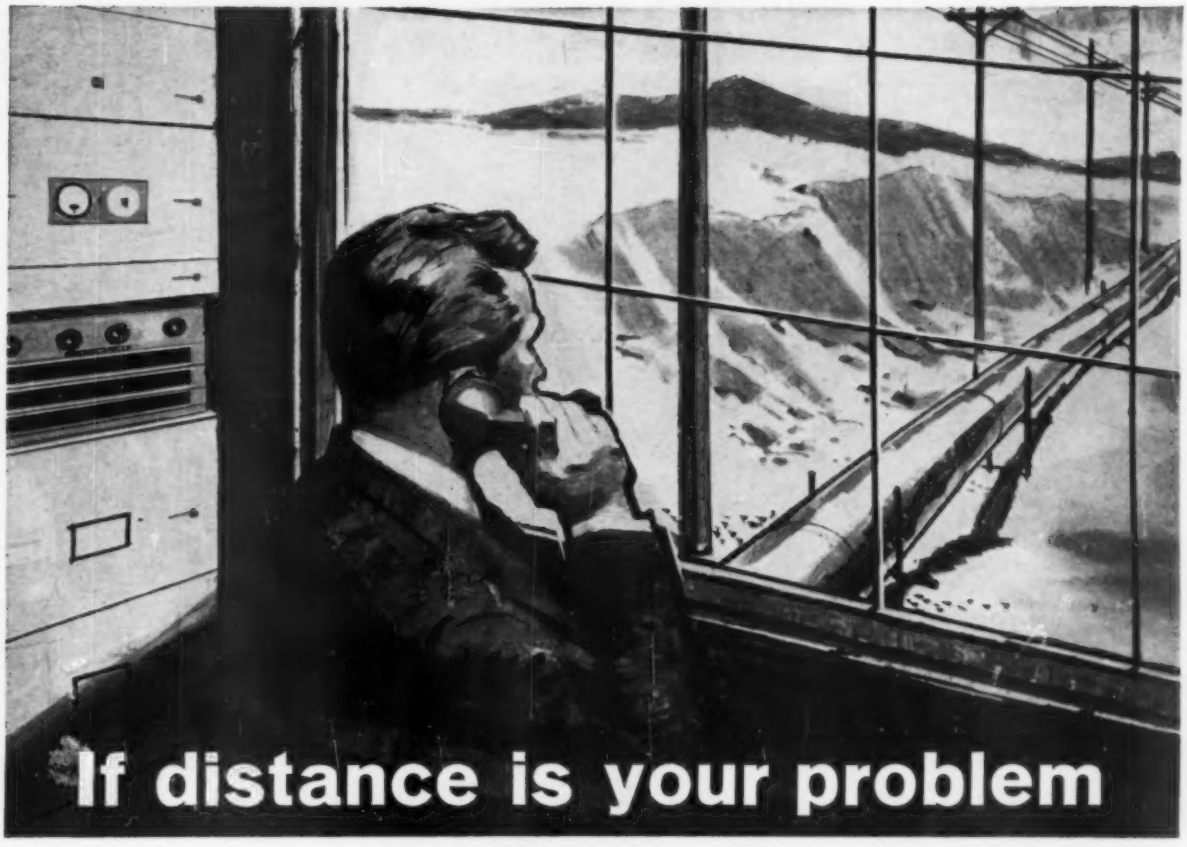
That's the way D. D. Vaughn, General Manager of Vaughn & Taylor Construction Co., describes the performance of the Gar Wood-Buckeye 318. Vaughn is using two 318's to dig 160 miles of pipeline ditch near Dumas, Texas, for the Shamrock Oil & Gas Corporation. He reports that each machine is digging 17 to 18 feet per minute, without any strain. He plans to add a third 318 soon.

This performance is made possible by Torq-matic Converter Drive, an exclusive feature of the 318 that automatically adjusts the torque required for the work load, automatically maintains a constant output shaft speed. Matched to Gar Wood-Buckeye's modern power train and advanced hydraulic systems, the torque converter makes the 318 the top performer for pipeliners.

You can enjoy the same increased production and reduced fuel and operating costs. Ask your Gar Wood-Buckeye dealer about the 318, the most advanced pipeline ditcher you can buy.



FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



If distance is your problem

take a long look at *Lenkurt* carrier

ALL YOUR
COMMUNICATIONS NEEDS
FROM ONE
DEPENDABLE SOURCE

Lenkurt Type 32E Carrier Equipment is the most economical and efficient means of adding long-haul communications channels to existing wire lines.

By using single sideband suppressed carrier transmission and automatic pilot control, reliable communications under the most adverse weather conditions can be achieved over almost any distance.

Type 32E terminals are equipped with either 3 or 4 channels in the 3- to 35-kc range, and can be applied over v-f circuits. System levels and frequencies of the 3-channel equipment coordinate with those used in Western Electric Type C carrier units.

The AE-Lenkurt team of telephone engineers is equipped to handle as little or as much of the planning and installation as you wish. And AE will provide "follow-thru" service *for the life of the equipment*.

For full information on the Lenkurt Type 32E or companion equipment, call your Automatic Electric representative, or write the Director, Petroleum Sales, Automatic Electric Sales Corporation, Northlake, Illinois.

AUTOMATIC ELECTRIC

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GENERAL SYSTEM

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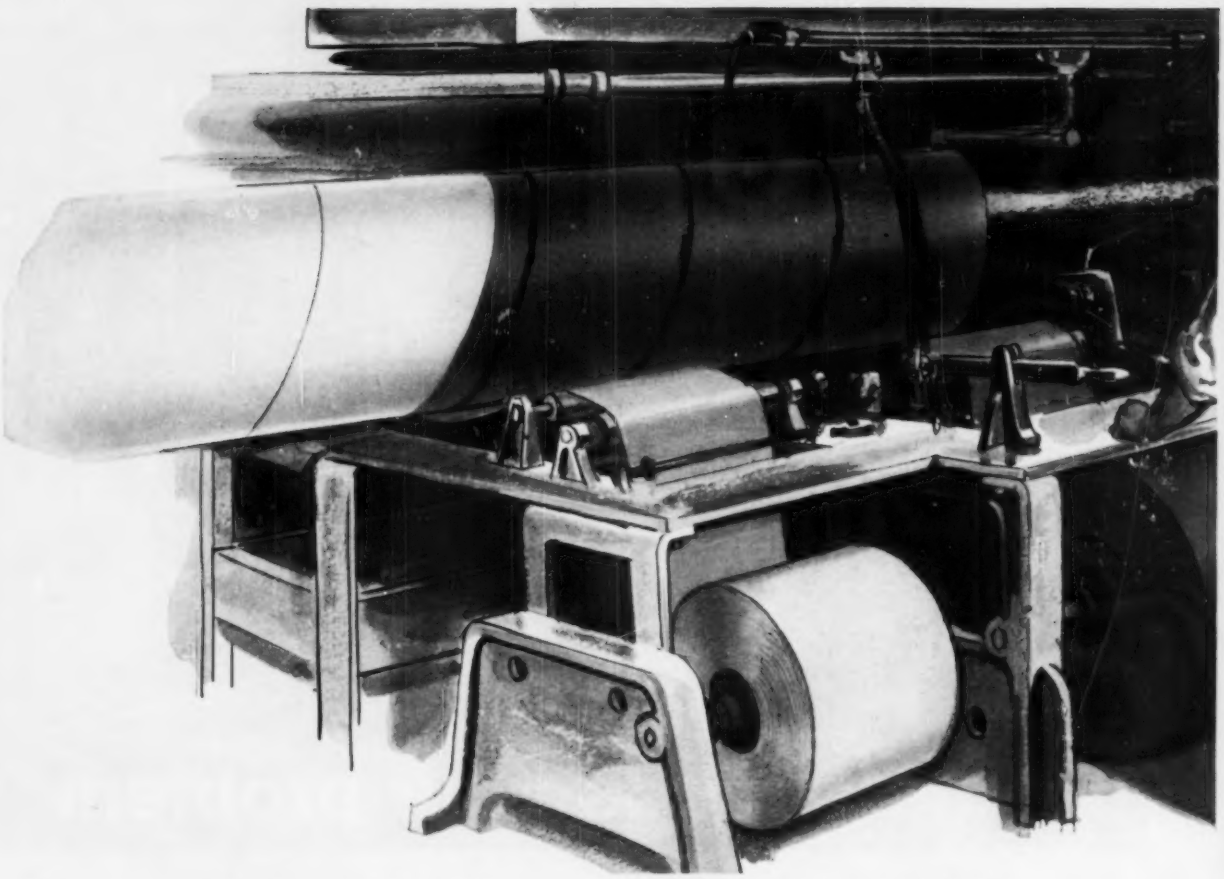

Specify Johns-Manville Partners in Protection for all your pipe– mill or field wrapped

J-M BLUE FLAG for enamel reinforcement

J-M ASBESTOS FELTS for a tough outer shell

J-M FLEXIBLE ROCK SHIELD for added protection against hazards of rugged, rocky terrain

When you specify the Johns-Manville system of pipe protection, you're sure of the maximum security for your lines. Both J-M BLUE FLAG and J-M ASBESTOS FELTS are designed with modern, high-speed wrapping machinery in mind. And you get all these advantages:

- **TROUBLE-FREE APPLICATION**
  –no unusual or complicated requirements
  –long rolls of wrap mean fewer stops
- **PERMANENT BOND WITH THE PIPE**
  –no pressure-sensitive adhesive to deteriorate
  –no voids under spiral laps
  –no moisture migration
  –no "operating room cleanliness" of pipe required to secure a good bond

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MEET 3 PARTNERS IN PIPELINE PROTECTION FROM JOHNS-MANVILLE

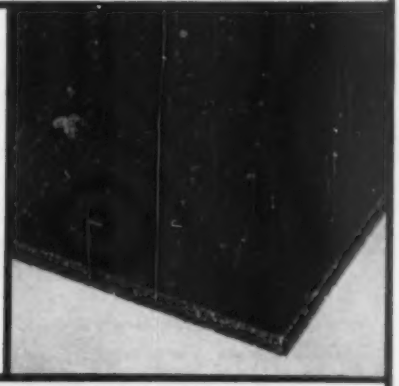
1

J-M BLUE FLAG Fiber Glass Wrap is a mesh of reinforced glass fibers that cannot rot, decay or absorb moisture under ground. Blue Flag lets enamel bleed through evenly until the wrap becomes an integral part of the coating. Uniform porosity prevents "holidays" as it assures consistent build-up.

2

J-M ASBESTOS FELTS, impregnated with either asphalt or coal-tar, are available in several weights to meet varied job requirements. These asbestos felts provide a flexible covering of stone, and have served as a tough outer shell on pipelines throughout the world.

3



J-M FLEXIBLE ROCK SHIELD is an asphalt-mastic composition board with a laminated felt surface. Its flexibility conforms to any pipe size, and its resilience provides the cushioning required in rugged rocky terrain.

- **DEPENDABLE RESISTANCE TO DAMAGE**
  –during handling
  –during backfilling
  –throughout the life of the pipe, J-M Blue Flag plus J-M Asbestos Felts give proven protection against soil pressures and chemicals . . . assure successful, low-cost operation of cathodic protection

- **FOR UNUSUAL CONDITIONS,** there's one more J-M Product you can use–a *third partner in protection*–J-M Flexible Rock Shield. It cushions the lines against rock penetration during backfilling and in service. J-M Flexible Rock Shield provides more dependable, lower-cost protection than dirt-padding, and conforms readily to all pipe sizes.

For further details about Johns-Manville Pipe Wrap materials–*three partners in pipeline protection*–see your nearest J-M Representative, or write to Johns-Manville, Box 158, Dept. (Key), New York 16, N. Y.

JOHNS-MANVILLE

BLUE FLAG is a registered trademark of the Johns-Manville Corporation

JOHNS MANVILLE JM PRODUCTS

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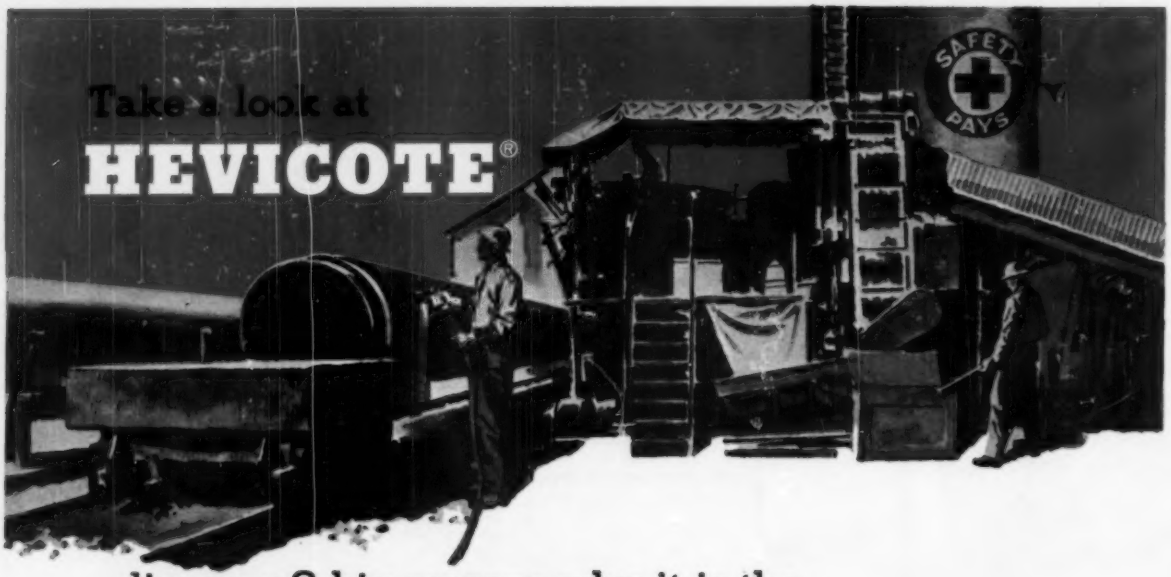

discover 3 big reasons why it is the PREFERRED Concrete Pipe Coating!

Years ago, the H. C. Price Co. Pipe Coating Division pioneered the first concrete pipe coating. Since then, constant improvements have been made in the Price Co. manufacturing and application processes, and in the coating material itself. Here are three of the many reasons for choosing HEVICOTE® pipe coating when weight is needed on your line.

Accurate Weight Control—Through the pre-tested use of aggregates of varying weights, HEVICOTE® pipe coating delivers the displaced weight required by the customer's specifications. In addition, each joint of HEVICOTE®-coated pipe is measured for length and circumference, weighed, and marked at each plant to guarantee the required specific gravity and to facilitate on-the-job placement.

New Extrusion Process—Now, exclusively from H. C. Price Co., an extruded HEVICOTE® that gives a smoother, more uniform surface, which facilitates field molding, handling, and laying.

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Get the facts about HEVICOTE®, and the combination of this superior concrete coating with SOMASTIC® or any chosen anti-corrosive coating. Because of its greater weight, SOMASTIC® reduces the quantity of weight material required and in some cases can eliminate entirely the need of additional weight. Call the Pipe Coating Division Plant nearest you for free consultation.

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HEVICOTE® brochure, with weight and displacement tables, and results of scientific examination of SOMASTIC®-coated pipe, plus a newly issued booklet on SOMASTIC® uses and specifications are now available. Return the coupon for this free material.

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Obstacles Overcome to Keep Mexico's

Big Gas Line on Schedule

M. SAINT ALBANS

▶ PETROLEOS MEXICANOS' 500-mile, 24-in. gas line, with only 150 miles to go, is scheduled to tap southern Mexico's big gas reserves at Pemex City before the end of the year. Thus many of the ever-increasing number of industries in the Federal District and adjoining states of Hidalgo and Mexico will be burning natural gas for the first time in their history.

Construction work on this *gasoducto*, Pemex's first really big-time pipeline, is on schedule, a formidable feat when one considers that most of the job is Mexico-engineered and the pipe and heavy coating material are Mexico-made. The undertaking usually is referred to as GCPM, convenient shortening of Gasoducto Ciudad Pemex Mexico.

Digging trenches and laying pipe began just a year ago. Under the aegis of Ing. Xavier Paredo, pipeline boss for Petroleos Mexicanos, engineers had been surveying the project, testing subsoils and river sands and currents, assaying rock formation, and working over drafting boards since 1956.

The end of 1957 saw the entire line mapped and in 1958 the right-of-way was practically cleared.

At the beginning of 1959 Mexico had a new president, Lic. López Mateos, and soon thereafter a new head of Pemex, Ing. Pascual Gutiérrez Roldán, former head of the nation's largest steel plant. He took over from Senador Antonio Bermúdez, who in 12 years had built the government oil industry into a world respected organization.

At this time, too, came changes in high personnel but not in the GCPM department. Ing. Xavier Paredo stayed on as pipeline boss and Ing. Bruno Mascanzoni, Ing. Héctor Lara Sosa, and Ing. Eduardo Rugama, senior members of Pemex higher engineering echelon, as advisory consultants.

By May, Nacional Financiera had arranged foreign financing and a contract was awarded to Constructora de Ductos, S. A., a joint venture of Con-

Traffic was detoured for two days while this highway crossing was being made between Minatitlan and Coatzacoalcos.

structora El Aguila, S. A. de C. V. and CUPSA or Carreteras Urbanismo, S. A. With the exception of eight highly unpredictable river crossings, the contract included the entire line of 770 kilometers (480 miles). Recently, however, Petroleos contracted 29 kilometers (18 miles) of almost solid rock, which traverses a heavily populated ravine area and so is slow going, to Construcciones Universales Mexicanas, S. A.

By June 1959 men and machines were hard at work at Jaltipan in Veracruz and soon a crew took over at Venta de Carpio, the Valley of Mexico terminus.

Work In Two Sections

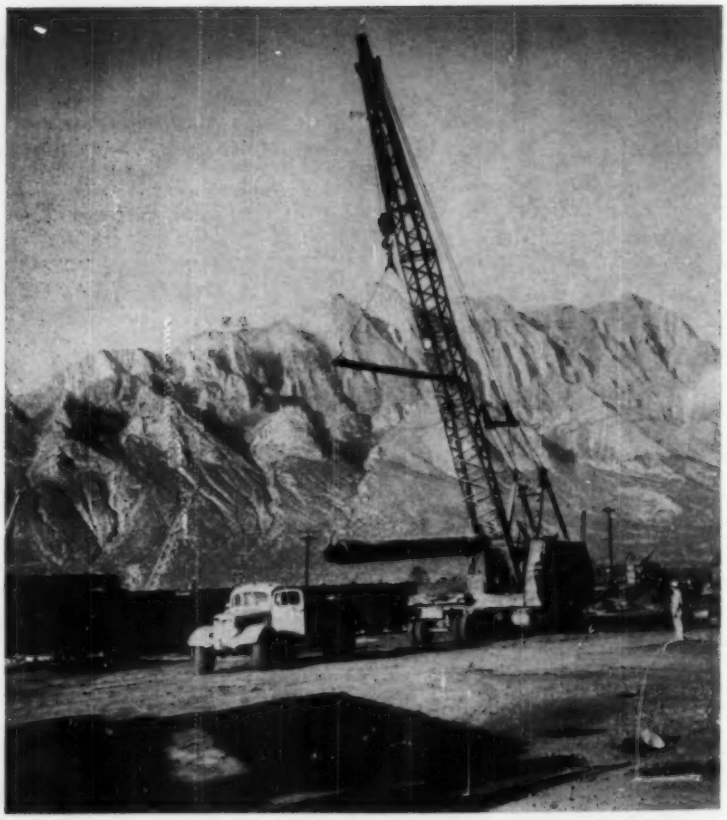
Ing. Paredo had divided the work into two sections or *tramos*. The upper section bisects the states of Mexico, Tlaxcala, Puebla, and a part of the lower half of Veracruz. The second section extends from the sulfur region of Jaltipan to cross the Coatzacoalcos River 11 kilometers (6.8 miles) from the Minatitlan refinery, and jog farther south to the Tonala River, which divides Veracruz from Tabasco's watery marshes, then bisects the state to Ciudad Pemex not far from the northern border of Chiapas.

The first section comprises two-thirds of the line; but the headaches are much smaller, say engineers. Yet Ing. Paredo does not minimize the difficulties of this first section. Beginning at a mile and a half altitude it rises to almost two miles to descend in no gentle fashion in up to 40 percent grades, traverses 90 kilometers (56 miles) of 90 percent solid rock, a part of which was through a heavily populated narrow valley.

This section also includes two overhead river crossings, as well as several large rivers that seem harmless in the dry season, but when the rains come, more often than not flood to cover a 10-mile wide area. Moreover, this section includes 98 of the 135 special crossings: Highway, railway, arroyos, large streams, and terrain subject to flash floods.

The Swamps of Tabasco

The herculean task, however, is the State of Tabasco. If you fly over Tabasco even in the spring you'll be amazed at the great stretches of water below. In one area the state boasts the third heaviest rainfall in the world. Riddled by downpours and by floods it has been Mexico's forgotten land. Now, however, the first of three giant dams, to cost a total of approximately a billion pesos, is under construction in the headwaters of the Grijalva River system and in time agriculture promises to vie in wealth with the present gas and oil bonanza.



Pipe is being transferred by truck with padded ends from concrete-coating machine to drying yard. Later it will be shipped by railroad to Tampico, then barged to the southern part of Mexico.

Although avoiding lagoons and swamps as much as possible, the line necessarily was routed through 22 kilometers (13.6 miles) of marshlands where water is continually on the move, and 190 kilometers (118 miles) of floodable land, along with vast stretches of highly unstable soil.

Executives of the Fish Service Corporation, Pemex's consulting firm for GCPM, say that Tabasco is much more difficult than Louisiana from a pipeline construction standpoint. In Louisiana, for example, barges can enter the marshlands to dredge canals through which pipe is pulled. Here, where marshes and lagoons and land intermingle, such a procedure is impossible.

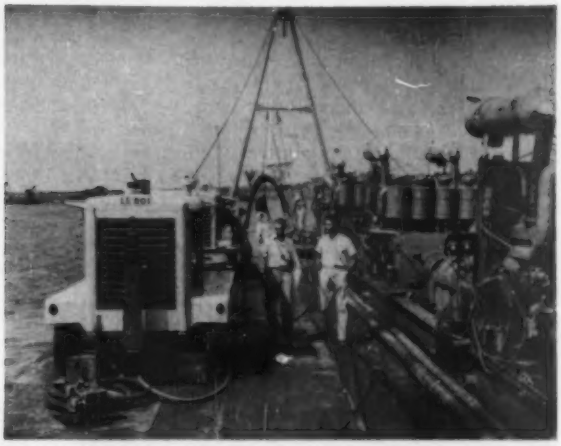
Fortunately, Pemex has had considerable experience in laying smaller lines in the area and the Pipeline Department immediately ordered 130 kilometers (80.7 miles) of marshes built up with earth fills. These are 10 meters (32.8 ft) wide with from 60 to 100 cubic meters (2119 to 3531 cu ft) poured on each square meter of surface. This greatly facilitates trench digging and pipelaying.

Even so, sometimes the lack of sufficient stable soil makes the use of ditching machines impracticable. Pemex solved this problem with manual labor, some 500 Tabasqueans with pick and shovel. In the United States with wages well over a dollar an hour such a procedure would be uneconomic. Here the fact that this wage pays for the entire day, and that many idle men in the vicinity seek work, puts a different aspect on the matter.

Because of earthfilling and human digging, no mats are being used, a saving of time and money.

The Coatzacoalcos River took three months to cross, due to constant stirring of river bed by Gulf tidal currents and passing marine traffic, as well as some equipment trouble. Here a tanker speeds by as trenching machine waits to get into action.

On board the trenching machine, used to lower pipe beneath the river bed, are Ing. Alfredo Villasenor, river crossing inspector, and Ing. Gustavo Ruiz, in charge of the Jaltipan-Ciudad Pemex section, for Pemex.



Launching unit for moving concrete-coated pipe into marshland.

In charge of this second section is Ing. Octavio Ruiz with headquarters at the Minatitlan refinery on the Coatzacoalcos River. Under his direction engineers supervise every phase of the work. Between the Coatzacoalcos and Tonala rivers the land ripples as if given a permanent wave by a giant machine. In this area, too, as farther south, the temperature sometimes reaches 95 F with excessive humidity in addition.

In the long haul from Monterrey, where the pipe is made, via truck, railway, coast and river barge, some pipe inevitably is damaged. For this reason contractors have put on a special beveling crew to work ahead of the welders.

In the southern section, 24 kilometers (15 miles) of concrete-coated pipe has been laid in areas subject to flooding and 22 kilometers (13.6 miles) in lagoons where it was pulled across. There are, also, 100 kilometers (62 miles) weighted with concrete blocks. These blocks are made in Nanchital on the Coatzacoalcos River or in Teapa, the only place in Tabasco where gravel is available, and trucked to the working areas. From Teapa the distance to the Ciudad Pemex area is about 150 kilometers (93 miles).

Condusa is using 42 pipelayers, 40 welding machines, eight backhoes, six draglines, numerous tractor trailers for stringing pipe, as well as numerous pickups and jeeps. In the lagoons the company provides a marsh buggy.

Launching units, larger replicas of those used in previous smaller operations, are made of lamina. Empty diesel fuel barrels fastened with steel bands to the top of concrete-coated pipe provide the essential buoyancy for marshland crossings while being pulled with tractors and cables.

Condusa headquarters in this area is Ciudad Cardenas with Ing. Jorge Cabezut in charge. In the field Ing. Victor Manuel Ramos of Condusa and Ing. Martinez Pena of Pemex, superintended the first marsh crossing, which is 3 kilometers (1.8 miles) wide.

This spring 26 kilometers (16 miles) was laid through marshlands and terrain subject to floods in 29 days, a record considered by foreign pipelaying experts as extremely good; they also cite the 3 kilometers a day in the Puebla area as an enviable record.

Headquarter offices for the northern section are in tropical Cordoba. Below Cordoba there are 26 kilometers (16 miles) of swamps where concrete-coated pipe was used.

South of Cordoba is the Amapa River, which is 145 ft wide, and Rio

Blanco, 290 ft wide. As both have solid rock bottoms, and could not be trenched, suspension bridges will be installed.

Underwater Methods

Indé Conducciones of Mexico and Collins Construction Company of Port Lavaca, Texas, are making the eight underwater crossings. Because pipelaying underwater requires special equipment and technicians, Pemex called in these submarine pipeline specialists. Collins recently laid the world's longest underwater line in the Persian Gulf. Indé, participating in the joint venture, recently completed oil and gas lines from Monterrey to Torreon.

This latter company provides compressors for hydrostatic testing and supplying air for the trenching machine, draglines to dig launching sites and exits and, equipped with clamshells, to dispose of debris brought up by the "yo-yo" buckets; also welding machines, pipelayers, and transportation vehicles for men and machinery. In addition to the barge-based launching unit, Collins shipped by sea two sets of all machinery so that two river crossings could be installed simultaneously.

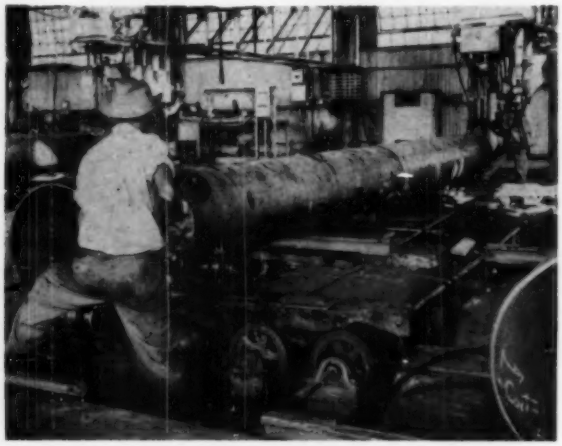
The contract was let in October. Immediately, Indé engineer Adolfo Banuet along with Collins project manager Tom Broome, and project engineer Joe West inspected the eight rivers by airplane, river boat and jeep. This took time, and later red tape slowed importation of equipment so that work on the Coatzacoalcos River did not begin until well along in January.

The river crossing schedules follow: Coatzacoalcos, January-February; Tonala, February-March; Grijalva, March-April; Semaria, May; San Juan, June; Arroyo Obispo, June-July; Tesechocan, August-September, and Papaloapan, October.

The contract specified that the job be completed in October and that two deep trenches be dug 30 meters (98.4 ft) apart in each river; one for the 24-in. pipe, the other for a 12-in. emergency line. Trenches are 15 ft below the river bed, 50 ft wide at the top, and 8 ft at the bottom.

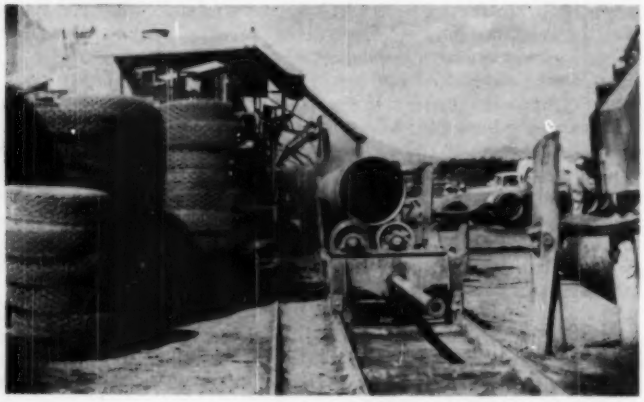
In late March, however, Pemex called for two additional 12-in. lines except in the Coatzacoalcos River where the government oil company had laid extra lines some time ago. This was motivated by the ever-increasing oil and gas reserves being discovered

Pipe was weighted with concrete blocks in areas subject to flooding. Although comparatively dry when this installation was made, during the wet season the line will be completely covered with water.



Pipe for the project was manufactured in Monterrey from steel made in Monclova, Mexico.

Concrete coating being applied to pipe in yard at Monterrey, Mexico.



in the area. Already Ciudad Pemex is doubling its absorption plant facilities and two smaller absorption plants are being installed near the Tabasco-Veracruz border.

The first river to be crossed was the Coatzacoalcos, the site 11 kilometers (6.8 miles) from Minatitlan. It proved a most difficult job and took three months to complete instead of an anticipated three weeks.

This river, one-half mile wide and only 15 ft deep, in the spring has a bed of hard silt and soft sand. As the locale is near the Gulf of Mexico, a 3-ft tidal current and frequent Pemex tankers and freight barges plying between Nanchital and Minatitlan keep the water and river bottom soil continually stirred up.

The result is a sort of elastic soup which does not adhere, consequently the trench walls kept caving, making construction progress exceedingly slow. Eventually, sufficient depth was obtained for pipe pulling, then later when the trenching machine went on the job to blow out the sand and lower the pipe to the required depth, it broke down and Collins had to send to Texas for special parts and special mechanics. After the trench for the 24-in. line was completed, the machine struck a ridge of hard rock on the second trench, necessitating the fashioning of a special plow to remove the obstacle.

Meanwhile work went on at Tonala, which fortunately has a more stable bottom, and arrangements were made for the Grijalva crossing. This river will be crossed just above the confluence of the Usumacinta and Grijalva rivers, a system seventh in the world in volume of water carried to the sea. After the Grijalva comes the Semaria, famous for its "breaks" when it goes on rampage destroying extensive areas of farm land. Now levees have been built, but engineers say all levees are make-shifts. Pemex, however, believes they will hold.

The difficulty encountered in all these rivers is soft soil, making launching entrances for the pipe and exits a delicate matter. If bushes and small trees are removed, as happened unwittingly in one river, the soil simply disappears.

Rivers in the northern section have harder beds, but are more inaccessible. They are about two hours from even a small town. One can only be reached over a cow path; however, in this case, the southern railroad line passes not far away and contractors expect to make the daily trip by handcar.

Apparently the crossing schedule for most of the rivers coincides with the flood season; but as the only alternative would be to postpone work for many months, Pemex and the contractors insist they will adhere to the original schedule.

The Papaloapan crossing in October should take place well after the wet season. Levees are 50 ft high from the river bottom and, according to Collins' engineers, resemble the cliffs of Dover. This calls for much excavation. If heavy rains should come in October the river could jump the launching site and do considerable damage.

Steel for the pipe came from Altos Hornos steel plant in Monclova, Coahuila, the original iron ore from the Altos Hornos' new mine La Perla in Chihuahua. In Monterrey, Nuevo Leon, Tubacero produced the pipe using a machine built in the shop for that purpose. River crossing pipe has a wall thickness of ⅝-in. and that used in swamps 0.344 in.

Pipe to be concrete-coated was hauled from Monterrey to Protexa-Price yards on the road to Saltillo. This firm was formed by Protexa of Monterrey and H. C. Price Company, of Bartlesville, Oklahoma.

The heavy aggregate is provided by Petroloid using a specially designed classifying machine that scientifically controls its quality.

All pipe is API grade X-52. Coating and wrapping are over the ditch.

The new system will have a capacity of 220,000,000 cu ft of gas a day without compressors. Of this, 175,000,000 cu ft will be used in Mexico City; 45,000,000 cu ft distributed to industrial plants along the way. When compressors are added the volume will be increased to 450,000,000 cu ft a day.

Lining up pipe joints for welding at launching site in one of the numerous swamp areas.

★ ★ ★

Tok Junction. Although quite isolated, Tok Junction and its pumping station and storage tanks are an important link in the pipeline system.

Alaska's Prototype Pipeline

With the oil search getting hot in the 49th state, the Alaskan Command's military complex may serve as a model for future pipelines

SMSgt. **Robert E. Nance,** *USAF*

A STEEL TUBE, 8-in. in diameter, that snakes its way over and under 626 miles of Alaskan and Canadian terrain has proved itself an efficient and vital link in transportation facilities that service the unified Alaskan Command.

The Army, Navy, and Air Force components, which make up our fighting forces in the new state, depend on petroleum products as their life's blood as does any military organization. But the system has done more than just supply fuel to energize Army tanks, Air Force fighter-interceptor aircraft, and an occasional GI cigarette lighter in the Fairbanks Logistical Area.

It has proved intrastate pipelines are feasible in Alaska and may one day become the prototype for a series of commercial lines that will move crude oil from wells to Alaska's cities. This probability stems from the fact that five good producing wells have been brought in on the Kenai Peninsula since 1957. A half dozen wildcats are now being drilled in the same vicinity and preparations being made to drill on leases where the producers are located.

Once the current volume of crude oil emanating from the Kenai field is doubled, it will no longer be practical to use trucks to haul it to the port of Seward, where the oil is transferred to tankers and barges that end their voyages at California refineries. Instead, it will be cheaper to lay a surface pipeline.

And that could well be just the beginning of pipeline construction, for geologists and oil company officials predict that $200,000,000 will be spent on Alaskan oil exploration in the next 10 years. All seem confident that before the decade is past, producing oil wells will be much more numerous than polar bears.

One thing they're not so sure of, is whether essential road construction will keep pace with them. Any Alaskan other than a hermit, is frank in admitting that his state lacks highway facilities. Some even seem to take perverse pride in the fact that there are more miles of paved roads in Brooklyn than in all of Alaska.

Pipelines in Future Oil Plans

Therefore, pipelines are a constant factor in the future plans of oil companies . . . companies that are aware that one day they may have to integrate pipelines into every mile of landscape along routes that separate their yet undiscovered oil fields from the nearest deep water ports.

Company officials are therefore impressed with the Haines-Fairbanks pipeline and with the fact it was built and placed in operation at a cost of only $41,000,000. The same persons are equally impressed by the military's need for the pipeline.

That need became obvious to military planners during World War II. It wasn't until 1950, however, that the Corps of Engineers contracted with the Fluor Corporation, Los Angeles, California, to furnish the essential design.

Two years were spent on that initial phase, so construction bids weren't advertised until 1953 when a joint venture organization, Williams Brothers, McLaughlin, and Marwell of Vancouver, B. C., Canada, was awarded the contract.

Although it was winter, crews began right-of-way clearance and in April

other workmen started welding main lines. Other tasks were accomplished by June 1955 when the first test run of fuel was introduced into the system. In October, the line was approved by the Corps of Engineers and the Quartermaster, U. S. Army, Alaska took over as the operating agency.

An Economic Asset

The pipeline proved an economic asset from the beginning and annual savings in transportation costs exceed $3,500,000. Alaskan Command's and U. S. Army, Alaska's logistical experts point out that the system will pay for itself during its first 15 years.

It is designed to carry five different fuels: Diesel oil, jet aircraft fuel, vehicle motor gasoline, and two types of reciprocating aircraft engine gasoline. One of the latter is in such small demand, however, that the line isn't used to transport it. Still, at least 1,000,000 bbl have traveled from Haines to Fairbanks via the pipeline each year, and usually the annual input is closer to 1,200,000 bbl.

The pipeline has proved an important but less obvious economic factor in another area, for it has helped exploit the already recognized favorable military potential that exists in the Fairbanks Logistical Area.

In the recent past, U. S. Army, Alaska established a series of NIKE-Hercules sites in that locale; at present, Alaskan Air Command and other USAF agencies with vital space-age interests are constructing a satellite-tracking station and other exotic technological devices in the neighborhood. These activities will place additional requirements on the pipeline and are plus factors so far as the civil community's prosperity is concerned.

One major handicap — weather — which had to be reckoned with throughout construction, has a definite bearing on operation of the system. Radical variations in temperature are the rule rather than the exception. In a single month, thermometer differences have ranged from a high of plus 40 F at Haines to minus 50 F up the line. In the course of a year, temperatures have varied from plus 92 F at Fairbanks to minus 83 F in the Snag area.

Unless the Russians are keeping some operation in Siberia secret, there is no parallel in pipeline operations, from a weather standpoint, anywhere in the world.

The system's primary reaction to temperature variations is a pressure change within the line induced by expansion or contraction of contained liquids. Such a situation can result in unfavorable interfacial mixing. The present control against it is induction of additional pressure to take up slack or bleeding of lines to counteract excess pressure.

River Crossing. The route the pipeline follows passes over many streams. Pictured here is Slim's River crossing, and the construction is typical of that used to overcome water obstacles.

To Use Spheroids at Interfaces

Modification of the system is being accomplished at present. It consists of installing a spheroid launching device at Tok Junction and a spheroid extracting mechanism at the Fairbanks terminal.

The spheroids are made from molded elastomer. When in use they will be filled with ethylene glycol and three will be inserted in the line to lead off each batch of liquid. Their presence will control interfacial mixing during times when fluctuating temperatures create excess pressures in the line.

Present modifications are confined to the line between Tok and Fairbanks. If sufficiently successful, similar devices will be installed on the Haines-Tok segment. It is possible to apply different techniques on the two spans because each is an entity in itself. By using the Tok pumping station as a focal point, they can retain separate identities or be transformed into a single unit.

A more standard aspect of the pipeline is the manner in which the builders took advantage of favorable topography to keep lines running level wherever possible. Although they were reasonably successful, there is still one spot where the pipe is 3750 ft above sea level and three locales where elevation exceeds the 3000-ft mark. This results in numerous miles of up-hill and down-dale travel, for the difference in elevation between Haines and Fairbanks is only 400 ft.

Other physical and mechanical aspects of the pipeline are fairly standard, too. The pipeline holds 210,000 bbl of fuel valued at approximately $1½ million. It operates at 1400-psi pressure and 16,800 bbl can be introduced into the system in a single day. It includes 190 miles of buried pipe and 436 miles above ground. The line travels underground where it passes through the Haines, Big Delta, and Fairbanks areas in order to present a minimum hazard to private property.

The first 42 miles of pipe stretch across Alaskan soil, then the line penetrates the Canadian border. The next 61 miles lie within British Columbia and the next 244 in the Yukon Territory, then it re-enters Alaska and the final 279 mile stretch terminates on Ladd Air Force Base.

The entire system is fairly accessible because it follows the Haines "cut-off" highway to the Canadian border and then the ALCAN highway generally parallels the remainder of the line.

A Quartermaster Corps officer, Colonel Dallas B. Pack, USA, is charged with operating the system, but this duty is only a part of his responsibilities. The colonel is commanding officer of the USARAL Petroleum Distribution Unit and as such, is charged by USARAL's Commanding General, Major General John H. Michaelis, USA, with ensuring that enough petroleum products are present in Alaska to meet all Army and Air Force needs.

The remainder of the staff consists of four officers, 18 enlisted men, and 194 civilians. ★ ★ ★

Pipeline Industry Takes a Close Look at . . .

SMALL TURBINES

Advantages are savings in cost of unit, station construction, maintenance, and operations . . . But an important question is their endurance

THE PIPELINE INDUSTRY is taking a close look at small, compact turbine units as a means of increasing capacity with minimum investment. The smaller machines, which will go on test this year in actual pipeline service, cost less to purchase, less to install due to smaller foundations and housing, less to maintain, and less to operate, it is claimed. Another feature is their light weight, this portability making them attractive for remote locations.

An important question is the durability of the new units . . . how long they can operate without overhaul. The final answer to this question will not be known until the tests are completed.

Of the tests scheduled, three will be on gas transmission systems and one on a products pipeline.

Designs of the turbine units are discussed below:

Solar Aircraft's Saturn T-1000

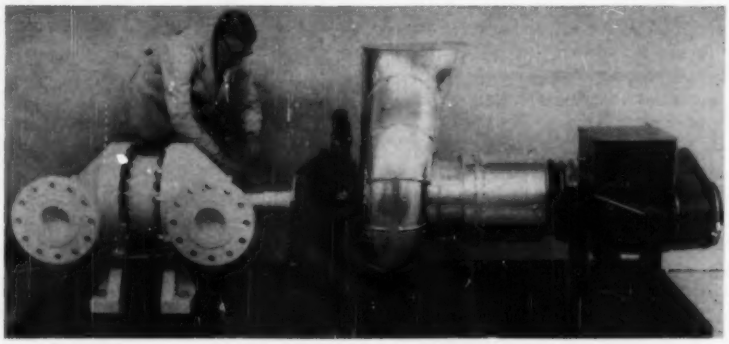
Solar Aircraft Company is entering the field with turbine equipment for both gas and products pipelines. The first unit of a new line of gas turbine-driven centrifugal compressors will be installed on the Trunkline Gas Company system. The gas turbine engine is designated as the Saturn T-1000. This same engine has been ordered by the Okan Pipeline Company to drive a booster pump on its main line.

The engine produces 1100 hp, and in the case of the Trunkline unit, total weight of the compressor and engine is about 5000 lb. Compressor rotating speeds range from 15,000 to 30,000 rpm to match the rotating speeds of the gas turbine driver, permitting direct coupling of the compressor and turbine.

The new compressor, applicable to field compression as well as main line stations, will operate from 75 to 1000 inlet cu ft per min up to 1500 psi, a range heretofore limited almost exclusively to reciprocating compressor equipment. This is due to the high compressor speeds, which make possible high compression efficiency of the smaller inlet volume flows. Another feature is a family of interchangeable compressor wheels to handle new flow and pressure conditions without changing complete units.

The Okan unit is a variable speed version of the 1100-hp turbine. In this application it will burn liquid butane for the most part, although it can burn other refined products such as kerosine and gasoline. Fuel will be taken from the main line and stored in a tank at the pump station site.

The T-1000 turbine is composed of three reaction stages, having a constant inner diameter and flaring outer diameter. The outer case is machined from a ring forging, forming a structural outer shell that supports the three turbine nozzles. Each rotor assembly is composed of machined, high-temperature steel alloy forgings that retain the precision cast turbine blading in "fir tree" mountings.



Mockup of Solar Saturn 1100-hp gas turbine engine (right) coupled to a centrifugal compressor shows how the engine-compressor unit will look when installed.

Cooling of the turbine is accomplished entirely with internally bled compressor air as an integral part of the engine design.

The combustion chamber is an annular section that provides a large volume for combustion and, therefore, results in low heat release. Design of the combustor, which allows the outer shell to be unbolted and moved back out of position so as not to require engine disassembly for inspection, makes for ease of accessibility and therefore better maintenance. Fuel nozzles also are readily accessible after removal of the outer shell.

An electric engine control system provides automatic starting and load regulation, as well as a complete monitoring system.

The fuel system is automatic and includes a fuel governor, acceleration control, fuel pump, and/or pressure regulating equipment.

Lubrication is by means of a closed-circuit oil system that includes oil pump, filters, and coolers.

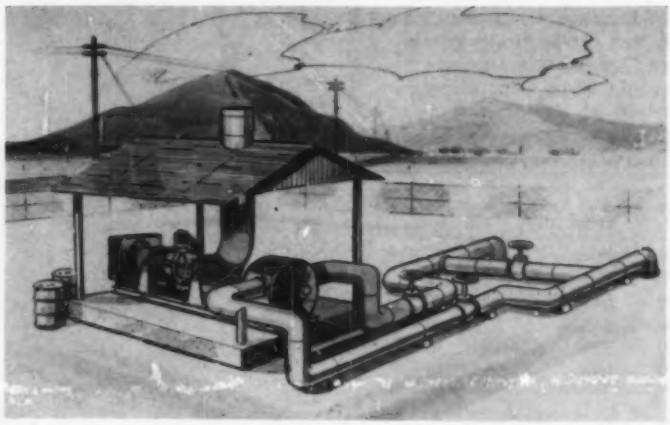
The T-1000 compressor is an eight-stage axial flow unit and is designed with a constant rotor tip diameter. The case is of welded stainless steel, which has a low coefficient of thermal expansion, and is formed as a cylinder with a machined bore. As the case is not horizontally split, there is a high degree of circular accuracy, which allows minimum blade tip clearance.

Each stator is split to allow assembly of the compressor without disassembly of the compressor rotor.

General Electric's High Speed Turbine

The General Electric Model 722 is one of two small gas turbine engines that Trunkline Gas Company will evaluate in main line pumping service this year at its Cypress compressor station on the outskirts of Houston, Texas. When operations begin in the fall with the two small gas turbines paralleling the main station, it will be the first time the new lightweight, ultra-high speed turbines have been placed in gas transmission service.

Already large gas turbines driving centrifugal compressors are becoming an important power source on large gas lines. If these new lightweight machines, which produce about a 1000 hp each and weigh a fraction of conventional prime movers, prove themselves in service, they will lead to substantial savings for the gas pipeline companies both in station construction costs and servicing economies.



This artist's drawing illustrates how General Electric's Model 722 gas turbine can be applied on a natural gas pipeline system as prime mover for a gas compressor. Starting later this year the engine will begin a one-year field elevation program on such an application at the Cypress station of Trunkline Gas Company.

Model 722 engine. General Electric's Model 722 produces 900 hp at a thermal efficiency of 22 percent. The engine with running accessories weighs about 300 lb and is 66 in. long. It consists of a 10-stage axial compressor with a moderately high pressure ratio of 8.3 to 1. Air is pumped at the rate of 12.4 lb per sec into an annular "straight-through" combustor. The compressor is driven by a two-stage gas generator turbine. A single-stage "free" power turbine in this two-shaft machine drives the output shaft at 19,500 rpm. In the Trunkline application this shaft will be coupled directly to a centrifugal gas compressor.

The natural gas control system is extremely simple, incorporating a minimum of moving parts. The system provides infinitely variable gas generator speed selection with fixed maximum selected speed, automatic acceleration, rapid deceleration, warning signal actuation, and manual shutdown through a solenoid shut-off valve.

Engine operating experience. The aircraft gas turbine which led to the basic design of the Model 722 has operated more than 30,000 hr during factory and field tests and in helicopter flight programs over a six-year development period. Two 2000-hr endurance tests are currently underway. One engine has passed the 1900-hr mark and the other is approaching 1700 hr. These are cyclic endurance tests in which each engine will achieve 4000 starts and 8000 accelerations at test completion. Cyclic endurance places more stress on an engine than will the steady state running at Trunkline. It is too early to predict the endurance of the Model 722 in the Trunkline application but the experience to date is encouraging.

Maintenance. Maintenance features will be a major contributor to operating economies. The 300-lb engine is light enough and small enough for two men to lift and transport in the back of a station wagon. Replacement engines can be installed in less than an hour, limiting down-time, and servicing can be conveniently done at a central depot. Split engine casings make for easy engine access and replaceable blades and other critical engine components simplify maintenance work.

Trunkline installation. At the Trunkline station Model 722 will be mounted on a skid with the high speed centrifugal gas compressor. The complete unit will be self contained and installed on a concrete slab and protected from the weather by a shed roof. The ambient temperature range for this installation will be from 20 F to 110 F. A test of 12 months duration is planned.

Significance of test. Pipeline companies are watching with keen interest the outcome of this test, which may have far-reaching effects on the growth direction of the pipeline industry.

These small, lightweight units make possible smaller compressor stations, and the elimination of massive foundations will result in substantial savings in building costs. The new machines are ideally suited to remote control because their operating accessories are self-contained and their fuel controls are easily adapted to telemetered signals. Also, in hard-to-reach locations the portability of the equipment eases the transportation problems and the small size of the machines makes it possible to accommodate them in locations where the foundations required by conventional compressor units would not be economically feasible. Remote control also makes possible the reduction and perhaps complete elimination of regular station personnel.

It still remains to be seen whether the new gas turbine units will prove themselves in service. The major question concerns their endurance. The new machines have not yet demonstrated endurance beyond 2000 hr. In use pipeline men will probably want a minimum of from 5000 to 8000 hr between overhauls. It is early yet to predict whether the new machines will achieve this endurance immediately but in the case of the Model 722, which has already achieved nearly 2000 endurance hours of cyclic running on liquid fuels, it seems probable that it will have better endurance in steady-state running with gas fuel. And, as has already been suggested, with multiple small units at a station the malfunction of one machine does not shut down the station and the ease of replacement makes for an hour or less of down-time on the machine in need of service.

The future. If the tests at Trunkline are successful they will probably lead to a much greater use of gas turbines as drivers for centrifugal compressors in the pipeline industry. The reduced capital investment for installed horsepower made possible with the new gas turbines will enable pipelines to expand more economically by building low-cost boosters between existing stations and pumping more gas through the existing pipes. In new pipeline construction small gas turbine booster stations at frequent intervals may make possible reduction in average pipe size with resultant savings in pipeline costs. — W. M. Meyer and A. Y. Fields, General Electric Company.

Latest Clark Turbines are Single Shaft

Two single-shaft turbine models are the newest additions to Clark Bros. Co.'s series for pipeline utilization, although the complete series includes both single and two-shaft designs in ranges from 8700 to 10,000 hp, which can be supplied with or without regeneration. Details of the units in this series are as follows:

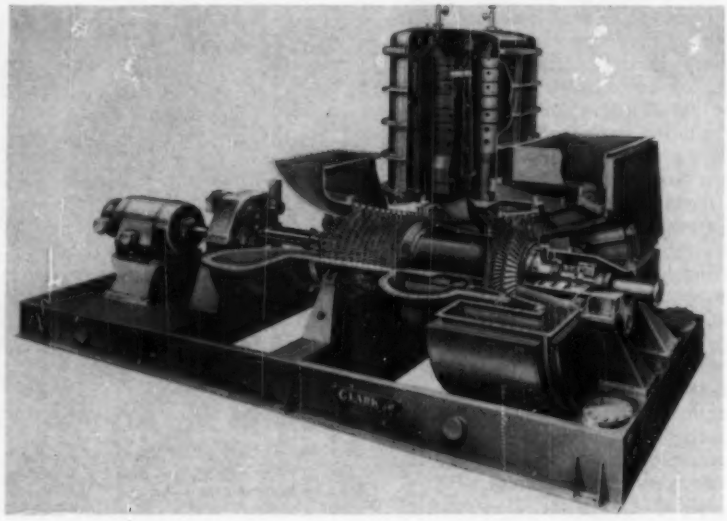
Model	NEMA BHP	RPM	No. of shafts	Fuel consumption, Btu/bhp/hr
302	9300	3600	2	12,050
306	10000	3600	2	12,050
305	8700	5000	2	12,800
307	9500	5000	2	12,800
305-S	9000	5000	1	12,130
307-S	10000	5000	1	12,130

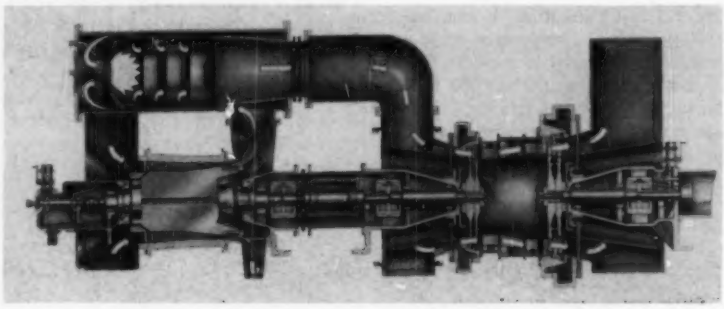
The new single-shaft turbines are designated as models 305-S and 307-S.

The complete turbine series has these features:

1. Contra-flow combustion chambers with air-cooled liners.
2. Air cooling of bearing supports, high temperature components, and outer skin surface.
3. All bearings are external for ease of inspection and maintenance.
4. Horizontally split cases.
5. Sectored stator blade sections.
6. Complete unitization of all utility piping and wiring.
7. Fabricated steel base mounting for ease of field alignment.

— C. R. Apitz, Clark Bros. Co.





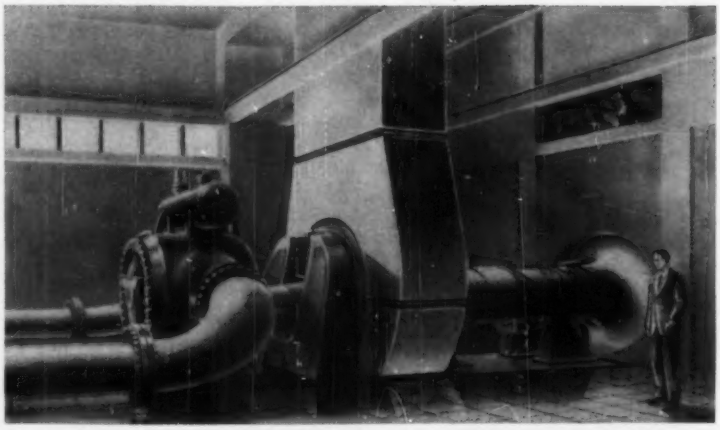
Cutaway views of the Clark single-shaft (top) and two-shaft (below) turbine designs.

Cooper-Bessemer's Jet Turbine

Being installed on the Columbia Gulf Transmission Company system, is the Cooper-Bessemer RT-248 gas turbine, which utilizes a Pratt and Whitney jet engine. The unit, first announced several months ago, has previously been discussed in these pages.[1] Basically, the jet engine is the generator portion of a power-producing gas turbine.

The principal difference between the RT-248 and gas turbine compressors already in use is that the former requires no regeneration although attaining comparable efficiencies. In conventional gas turbines, air to the combustion chamber must be preheated for maximum efficiency; however, this is not necessary in the RT-248 because incoming air is subjected to such high compression by the engine that air temperature reaches 600 F before entering the combustion chamber.

[1] "Why a Jet Gas Turbine?", by R. L. Boyer, *Pipeline Engineer*, March 1960, page D-42.



World's first jet-driven gas turbine for stationary power will go onstream in midsummer at Clementsville, Kentucky, compressor station of Columbia Gulf Transmission Company.

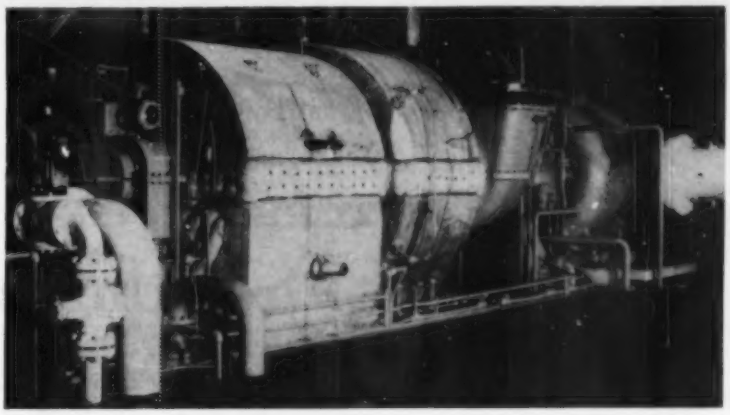
Installation cost is about half that of the more massive machinery, which is regarded as even more important than lower first cost of the machinery itself. Elimination of the regenerator with its cumbersome piping and ducts, makes it unnecessary to elevate the turbine on concrete piers or have a basement in the building, it has been pointed out by R. L. Boyer, vice president and director of engineering for The Cooper-Bessemer Corporation. Furthermore, the new unit is lighter in total weight and considerably smaller in overall dimensions than equipment in general use.

Sizeable savings in maintenance and operating costs also are foreseen. The jet engine is removable for major overhaul or repair. This will be an important factor in maintenance, as the engine can be removed and replaced with a spare in a matter of about four hours. The entire unit can then be shipped back to the factory for inspection and, of course, this also means that it will be unnecessary to maintain an inventory of repair parts or a crew of mechanics in anticipation of breakdowns.

The 10,500-hp unit weighs 12 tons. Three conventional gas turbines totaling 10,500 hp weigh 356 tons. Because of its light weight and portability it is being looked upon as particularly adaptable to remote locations. Columbia Gulf is especially interested in its possibilities for providing low-cost horsepower at intermediate stations, which would provide an economical means of increasing system capacity.

The test period, which is for 18 months or 8000 hr, whichever is the longer, is expected to begin in July.

What Westinghouse is Doing



A 7500-hp single-shaft regenerative gas turbine, one of Westinghouse's most recent installations, went into service last December.

Westinghouse installed the first gas turbine to pipeline service in 1949 and this unit continues in base load operation at Bonne Terre, on the Mississippi River Fuel Gas line. The 1800-hp gas turbine has accumulated more than 65,000 hr of on the line operation. This is a single shaft non-regenerative gas turbine that is installed in the last 60 miles of the gas line where gas flow conditions vary over a wide range. The single-shaft gas turbine directly coupled to a centrifugal gas compressor meets the gas line requirements satisfactorily.

With the early development of the 1800-hp unit it became evident that three features of the gas turbine were highly desirable. These are:

1. Disk-type bolted curvic coupled rotor.
2. Two bearings on each shaft, i.e., no bearings between the compressor and the turbine.
3. Turbine exhaust bearing supported on struts that are tangential to the bearing housing. This minimizes the differential expansion to hold the bearing central with the cylinder.

These features have been incorporated in all subsequent designs.

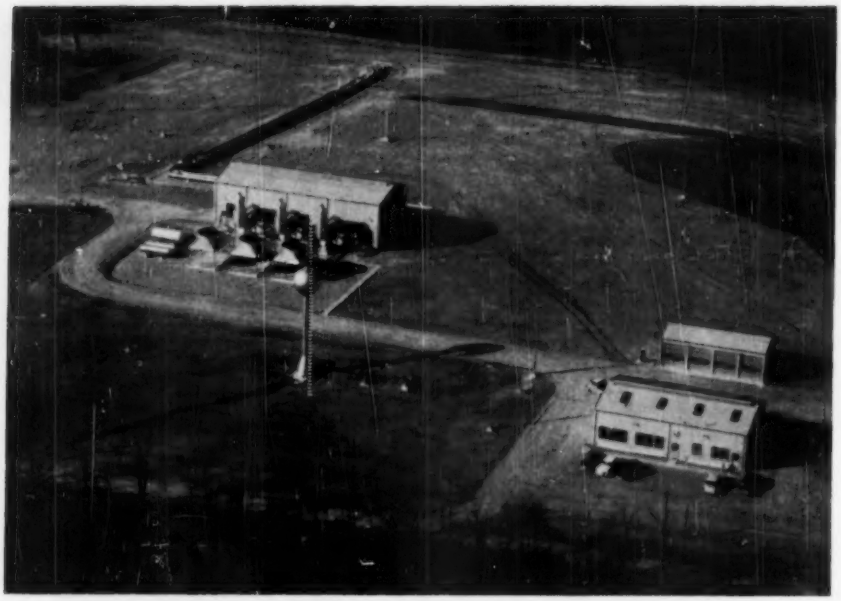
For liquid pipeline application and specialized gas line applications, split or dual-shaft gas turbines have been used. Westinghouse has 12 5000-hp dual-shaft regenerative gas turbines installed in four stations. These units have been in operation for the last four years, and have operated through the past two winter seasons without inspections.

The most recent application of Westinghouse gas turbines is a single-shaft regenerative 7500-hp machine that went into service last December (see illustration). This machine is less in first cost than the dual-shaft gas turbine and has one-half as many bearings thereby potentially reducing maintenance. The machine has operated 99.6 percent of the time since going into service. It compares favorably to the dual-shaft gas turbine in part load operation.

Based upon 10 years' experience in applying gas turbines to the gas line, we feel that a design philosophy of minimum number of bearings and seals provides the most reliable machine for gas line work and that careful review should be exercised by the operator of his requirements before turning to the dual-shaft machine.

For the liquid pipeline application the starting requirements are quite high, therefore, a dual-shaft machine is the practice. Currently, through our licensees we are assisting in the manufacture of 10 dual-shaft gas turbines rated 6000 hp on a 115 F ambient temperature for a large oil line in Iraq; also three of the same frame machines for a specialized gas line application.

During the last 10 years we have held to a turbine inlet temperature of 1350 F, which is conservative by gas turbine standards. During this period we have been completing our line of machines ranging in size from 3500 hp to 25,000 hp, as well as developing new high temperature alloys. We now are increasing the turbine temperature from 1350 F to 1450 F. This increases the overall thermal efficiency by 10 percent, making the gas turbine more competitive with reciprocating engines. — J. O. Stephens, Manager, Industrial Gas Turbine Engineering, Westinghouse Electric Corporation. ★ ★ ★



Aerial view shows relative location of equipment and buildings.

Clearly visible is the high pressure gas piping arrangement. Also, the fuel gas meter run, in the upper center section.

Tennessee Gas Installs Its First Unitized Stations

New design features safety, low maintenance and operational costs, compactness

Charles A. Falkenhagen, Jr.
Assistant Superintendent Compressor Stations
Tennessee Gas Pipeline Company

THE DESIGN adopted for four stations on its "Delta Line" embodies a concept new to Tennessee Gas Pipeline Company. The stations were constructed during the latter part of 1959 on a 30-in. system carrying gas from the Louisiana coastal area to Sumner County, near Portland, Tennessee. They are approximately 120 pipeline miles apart and have a total of 31,000 hp. Locations are near Bay St. Louis, Mississippi; Heidelberg, Mississippi; Columbus, Mississippi; and Collinwood, Tennessee. Working pressure of the system is 940 psig.

Primary considerations in designing the stations were safety, low maintenance and operational costs, and compactness.

Unitized Stations

These are the first unitized stations on Tennessee's system. Each engine drives its own auxiliaries (water pump and cooling equipment), and also has its individual jacket water and hydraulic system. A hydraulic pump, driven by the engine, supplies oil under pressure to a hydraulic motor, which drives the jacket water atmospheric cooler fan. Temperature of the water leaving this cooler is 120 F and this temperature is maintained by a controller that varies the position of a valve to bypass oil around the motor, which in turn varies the fan speed. Water from the jacket water cooler goes to the oil cooler, situated outside the compressor building, and from there to the engine to become the engine supply water.

A thermostatic valve maintains the engine jacket water outlet temperature at 160 F and hastens warmup by bypassing the cooler, a principle similar to the cooling system in automobile engines.

All piping between engine, oil, and jacket water coolers is above ground. If the engine water has to be drained for maintenance reasons, a jacket water rundown tank has been provided. This rundown tank is large enough to hold water from several engines, coolers, and piping, thus water is conserved and waste of chemicals eliminated.

Engines are equipped with full-flow oil filters only. Oil is drawn off downstream from these filters and used in the lubricators for both power and compressor cylinders. Three of the stations are using a mild detergent oil having a naphthenic base, the other station an additive oil with naphthenic base.

Valve Operators Controlled Remotely

As an aid to the station operator, each engine is equipped with remotely controlled valve operators on the high pressure gas piping. These valves, placed on the engine suction, discharge, and bypass lines, are remotely operated from each engine control panel by pushbuttons.

Due to an electrical interlock, the suction valve cannot be opened unless the discharge valve is fully open. The bypass valve receives its operation signal from the suction valve. When the suction valve is opening and is midway in its travel the bypass valve begins to close. When the suction valve is closing and reaches the midway point the bypass valve begins to open. It takes 90 seconds for the suction or discharge valve to operate fully and 15 seconds for the bypass valve. Momentary pushbutton contact will open or close the suction valve. For safety reasons the discharge valve pushbutton must be depressed during its full travel.

The normal valve position for starting engines is: Discharge valve open, suction valve closed, bypass valve open.

Engine Control Panels

Engines on the Delta Line are equipped with control panels designed and built by the respective engine manufacturers. These panels are both pneumatic and electro-pneumatic and in general perform the same functions. They will, when the signal to start the engine is actuated:

(a) Start a prelube pump (air driven) to flood all bearings with oil.

(b) Admit starting air to the engine and allow the engine to be purged.

(c) Turn on the ignition.

(d) Admit fuel gas.

(e) Bring the engine to idle speed.

(f) Shut off the starting air and prelube pump.

At this point the operator takes over and loads the engine by increasing engine speed and positioning the suction and bypass valves. Engine speed is controlled from the board by increasing or decreasing the air signal to the governor. The control panels monitor critical engine temperatures and pressures and will stop the engine in event of high jacket water temperature, low lube oil pressure, high lube oil temperature, low jacket water pressure, engine overspeed, or high turbine exhaust temperature.

To stop an engine, the panel closes the fuel gas valve first, then, as the engine rolls to a stop, the ignition is grounded and the prelube pump starts and operates for a 2-minute postlube period for cooling purposes.

Shutdown System

In keeping with the company's usual high safety standards, the stations employ an emergency shutdown system that will completely isolate the station from the pipeline, stop the compressor engines, and vent the yard piping in 2 minutes.

Natural gas stored at station discharge pressure is used to operate the station side valves and yard blow-off valves assuring the necessary energy in case of an emergency. Such systems are used at all Tennessee Gas Pipeline Company stations.

Other Features

Other features of the Delta stations include a central pyrometer board for all engines, where the operator may observe exhaust and turbine temperatures of each engine.

Air-powered hoists are used in the compressor buildings.

Exhaust silencers and piping are jacketed with sheet aluminum.

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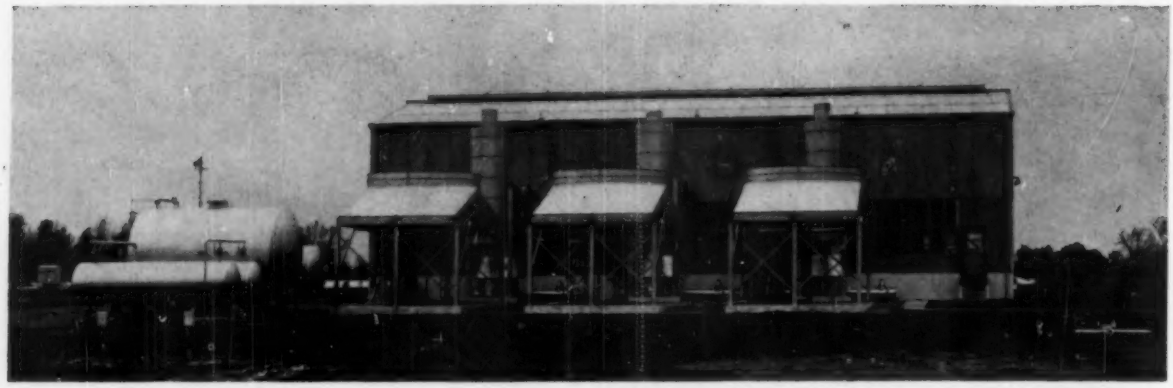

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Engine water make-up is automatically accomplished and controlled.

Station discharge temperature is transmitted from the yard and recorded on the station control board along with station suction and discharge pressures. Starting air pressure, gas supply pressure, and suction and discharge header pressures are displayed on this control board.

The station control board is located at the permanent end of the compressor building next to a soundproof booth housing a leased line telephone for communicating with the dispatcher and other stations, an intercom phone for communication between buildings within the plant site, and a bell telephone. In addition to these communication facilities, a two-way radio is located in the office.

Power is purchased at each station, but, in event this power fails, a gas engine driven emergency generator will start automatically and supply all power requirements, except for the air compressor. (The air compressor has its own emergency gas engine driver.) A timer on the emergency generator is so set that it will run 30 minutes once a week, to charge the wet cell battery and assure operation.

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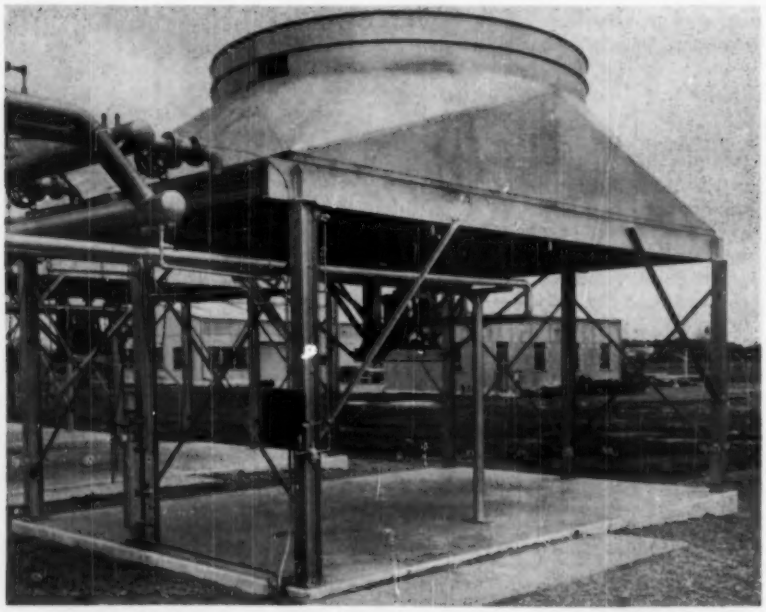

This closeup of an atmospheric cooler shows the water temperature controller and oil piping arrangement to the hydraulic motor.

Station Buildings

Stations have only three buildings. One is used to store pipeline equipment, and another is a combination office and shop building that doubles for a warehouse and auxiliary building and houses the station air compressor, switchboard, and emergency generator.

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Coating Yard Features Automatic Operation

LLOYD F. BRAMBLE
President, Gulf States Asphalt Company

Pipe for the Transco job was received at the coating plant in random 60-ft joints, double-jointed at the factory.

Joints were cleaned internally by machines with revolving cleaning heads, and compressed air to blow rust and scale from the pipe.

PRODUCTION LINE TECHNIQUES and near-full automatic operation are used to speed cleaning and coating of pipe in a new half-million-dollar permanent yard of Syd E. Culbertson Company, Houston, Texas. Reduced labor costs and rigid quality control are major results.

The plant is equipped to coat and wrap pipe from 4 in. through 36 in. diam; to straighten and recondition older pipe; to pickle and clean pipe chemically, and to perform other special operations.

Transcontinental Gas Pipe Line Corporation's recently completed order, internal cleaning and coating and external coating and wrapping of 42 miles of 30-in. pipe, illustrates the operation. Transco, a pioneer in the use of internal coating to reduce friction and increase gas throughput, used an epoxy resin coating as a lining in the pipe.

Cleaning was made more difficult than usual by the condition of pipe surfaces; well weathered and rusted after stockpiling on the West Coast for more than two years. Extra length joints were difficult to handle; random 60-ft factory double-jointed sections instead of the usual 40-ft pipe.

After mechanical cleaning and coating of the interior, sections were grit blasted, primed with asphalt primer, and coated with a minimum 4/32-in. application of hot-applied asphalt enamel. Coating was reinforced with glass fiber and wrapped with felt and kraft paper. Coated and wrapped joints were loaded directly from cooling racks onto flat cars and shipped by rail to Transco's construction project.

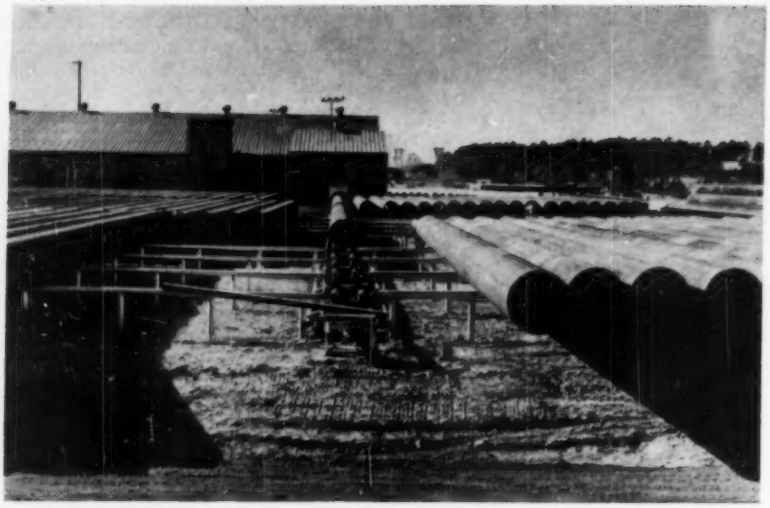
Internal Cleaning

Pipe joints were mechanically cleaned internally by machines with cleaning head mounted on the end of a drive shaft supported by a boom and revolved by a power unit. Compressed air blows rust, scale, and other foreign material from the pipe. The entire rig is mounted on a narrow gage track.

Two machines were used to clean the pipe joints. One machine made two complete trips through each joint, removing additional rust and scale with each pass. The second machine made one cleaning pass, then, as the head was drawn back through the joint, coating was sprayed on the inside of the lengths by four spray nozzles fixed to the head. Spray nozzles were set to give a 4-mil thick coating of wet paint. Thickness of the dry coating averaged 1.9 mils, well above the 1.5-mil thick minimum requirement.

Automatic Pipe Handling

Following the course of a joint of internally coated pipe in its journey from storage racks, through the clean-



Pipe being loaded automatically into plant for application of coating and wrap after being cleaned internally.

ing and priming machine, and into the coating and wrapping head, illustrates the degree to which automation has been carried in the plant.

Production was more than doubled over the company's previous process by a new patented method of moving pipe joints through the coating and wrapping machine in a continuous stream. Normally, forward movement of the pipe is halted momentarily until "come-alongs" are inserted between joints to permit the rotating disk on the conveyor rack to move sections into the coating and wrapping head in a continuous stream. This step is eliminated by a patented electro-hydraulic pipe rotating "buggy," which moves the joints along without need of a "come-along" between sections.

This machine picks up the end of the pipe as it comes through the coating and wrapping head and synchronizes the rotation with the rotating disk. The buggy continues outward from the coating head on a track until the pipe clears the equipment. Meanwhile the next joint has been shoved into the rotating disk by endoing rollers on the incoming pipe rack.

Weld areas of the coated and wrapped sections are trimmed by hand as the lengths are tripped off the rotating "buggy" and the joints are "jeeped" as they are placed on the cooling boards.

These cooling boards, although one of the simplest parts of the installations, are one of the most important features in the plant. They are heavy concrete and steel platforms, covered with steel plate, set 45 deg from vertical. One of the racks is fixed whereas the other may be moved to accommodate varying pipe lengths. Coated and wrapped pipe is supported only on the bare ends, eliminating damage to the finished sections.

Gas-Fired Dryer

As Transco's pipe was started through the coating and wrapping process each joint passed through a gas-fired dryer to remove any moisture from the metal. This heat also helped loosen heavy scale. A grit and shot blast process prepares the pipe surface for the primer. The cleaning machine uses minute steel shot, accelerated to high velocities on the rim of a large wheel situated below the pipe, to blast mill scale, rust, and other foreign material from the steel surface, thereby preparing an anchor pattern for primer to adhere to.

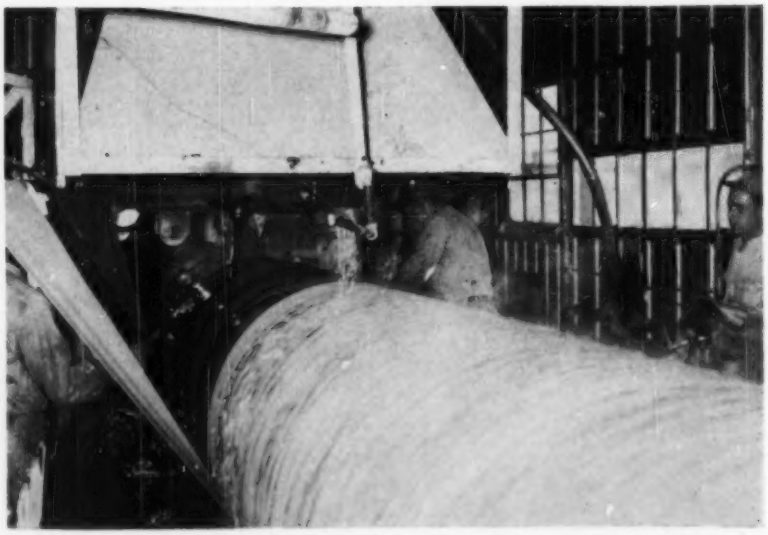
Asphalt primer was applied on a bright, though slightly matted surface, immediately behind the cleaning machine, then the primed joints were tripped onto a curing rack. These racks are in a completely enclosed and roofed room where humidity is closely controlled by gas-fired heaters and blowers. Hot air, blown through this curing room also cures the primer, from the metal outward.

Primed joints, after thoroughly curing in a dust-free atmosphere, were then gravity fed onto motor-driven endoing dollies, which moved sections through the coating and wrapping machine.

Felt outer wrap was furnished on order in 5000-ft rolls. Standard length is 400-ft. The long rolls permitted a continuous run through the coating head with a minimum number of shutdowns to change spools.

Enamel was chopped from containers in a roofed, concrete-floored platform, and the small chunks of cold enamel dropped through chutes directly into heating kettles below. This eliminated a possible source of contamination. Workmen also could add enamel to the supply in the pot as the hot material was used without shutting down the kettles and waiting for the dope to heat.

Coated and wrapped joints were jeeped after they were tripped onto the cooling racks with a special electronic holiday detector constructed for this plant. The "jeep" indicated holidays in the usual manner — a loud buzz as well as an angry snap from the electrode when current hit bare metal, but, in addition, dials were installed on the equipment to indicate at all times the exact voltage and amperage the machine delivered. ★ ★ ★



Coating was to a minimum thickness of 4/32-in. reinforced with glass fiber and wrapped with felt and kraft paper.

Underground Corrosion and Methods of Control

PART 5

O. C. Mudd, *Consulting Engineer, Alpine, Texas*

CATHODIC PROTECTION

The fundamentals of cathodic protection were stated in the discussion of electrochemical cells, viz., by the control of current flow to establish and maintain a cathode over the entire structure surface exposed to the corrosion elements of the soil electrolyte.

Such cells involve modifications of the usual laboratory cell of equal or near equal electrode surface areas, as most cathodic protection installations have cathode areas many times that of the anode and the ratio of these areas depends upon a number of factors that vary with each installation. The basic factor, however, is to establish as extensive a cathode surface as possible with a minimum of anode surfaces at the lowest practical cost of installation and subsequent operation (Fig. 11).

The extent of a cathode surface and the degree of effectiveness is determined by measurement of the voltage between structure and soil. This voltage difference must exceed that of any voltages of reaction between soil chemicals and structure metal in establishing complete protection, and this voltage will vary according to the metal and its environment.

Tests and experience have demonstrated that low carbon steel in normal soil suffers no apparent corrosion when the cathode surface is maintained at a potential 0.3 v negative to the contacting soil.

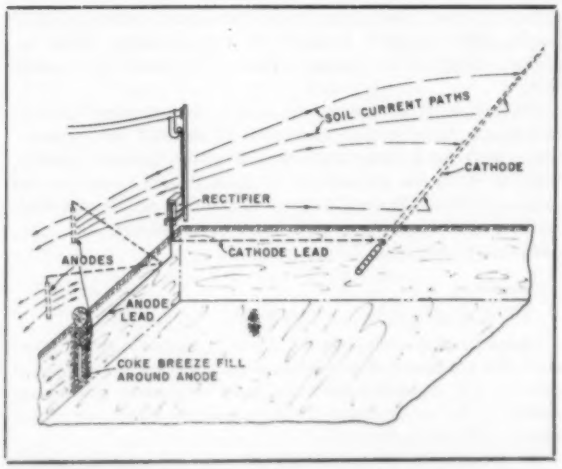


FIG. 11. Illustrating installation of a generated power unit.

This normal protection potential measured between structure and soil, with a copper sulfate soil contact electrode, is about equivalent to 0.3 v negative when the instrument indicates 0.85 v negative or 0.58 v negative when using a calomel electrode.

It is seldom practical, or economical, to establish a uniform cathode-to-soil potential along extensive structure surfaces, hence it is common to have abnormal potentials opposite or near the anode installation. Such potentials cause waste of energy and may even cause damage to the structure coating. Also, there have been indications of hydrogen embrittlement of metals where protective voltages were high.

Protective voltages maintained below the water decomposition voltage for the metal and environment will minimize energy waste and likelihood of other damage by excessive hydrogen liberation. Structures having protective voltages not exceeding 3.0 v negative to soil (with copper sulfate electrode) are not known to have suffered damage attributed to excess gas liberation.

Current requirements in establishing complete protection on underground structures depend upon the amount of the metal surface in contact with the soil. Thus it is evident that surfaces with no coating require more than those with some degree of coating whereas well-coated lines require very little.

Conditions have been encountered where soil was of a type restricting current flow below that necessary to establish a satisfactory cathode condition on the adjacent bare pipe surface. In other types, such as dense clays, that have a high degree of shrinkage with loss of moisture, part of the soil-to-metal contact is lost during dry periods and uncoated pipe has had leaks occur along the side even when the measured pipe-to-soil potential was more than 0.3 v negative.

Uncoated lines in highly corrosive soil may require amounts of currents that justify raising and coating. Tests have been conducted on a 10-in. line where 6 amp were required for each 100 ft of line, or approximately 20 milliamperes per sq ft of metal surface.

The other extreme is found with well-coated lines. Protection has been accomplished on 30 to 40 mile lengths of 20 to 24-in. diam lines with only a few amperes.

Practical application of cathodic protection for extensive underground structures resolves into determining current requirements and the most favorable locations for anode installations, with available power supply at or near these points established by tests.

Aerial view shows relative location of equipment and buildings.

Clearly visible is the high pressure gas piping arrangement. Also, the fuel gas meter run, in the upper center section.

Tennessee Gas Installs Its First Unitized Stations

New design features safety, low maintenance and operational costs, compactness

Charles A. Falkenhagen, Jr.
Assistant Superintendent Compressor Stations
Tennessee Gas Pipeline Company

THE DESIGN adopted for four stations on its "Delta Line" embodies a concept new to Tennessee Gas Pipeline Company. The stations were constructed during the latter part of 1959 on a 30-in. system carrying gas from the Louisiana coastal area to Sumner County, near Portland, Tennessee. They are approximately 120 pipeline miles apart and have a total of 31,000 hp. Locations are near Bay St. Louis, Mississippi; Heidelberg, Mississippi; Columbus, Mississippi; and Collinwood, Tennessee. Working pressure of the system is 940 psig.

Primary considerations in designing the stations were safety, low maintenance and operational costs, and compactness.

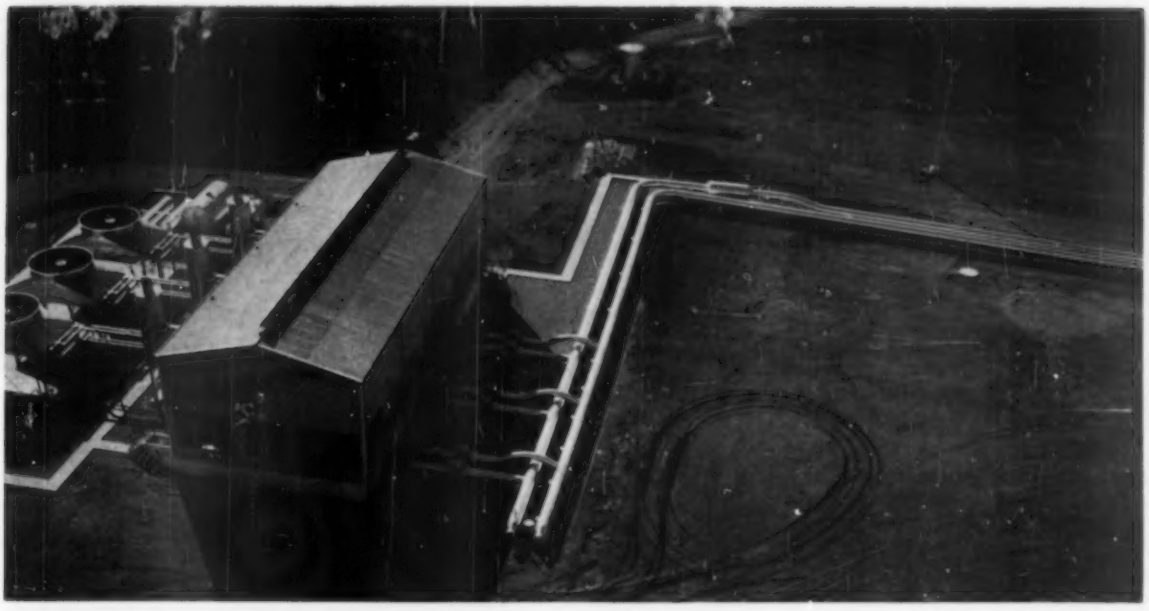
Unitized Stations

These are the first unitized stations on Tennessee's system. Each engine drives its own auxiliaries (water pump and cooling equipment), and also has its individual jacket water and hydraulic system. A hydraulic pump, driven by the engine, supplies oil under pressure to a hydraulic motor, which drives the jacket water atmospheric cooler fan. Temperature of the water leaving this cooler is 120 F and this temperature is maintained by a controller that varies the position of a valve to bypass oil around the motor, which in turn varies the fan speed. Water from the jacket water cooler goes to the oil cooler, situated outside the compressor building, and from there to the engine to become the engine supply water.

A thermostatic valve maintains the engine jacket water outlet temperature at 160 F and hastens warmup by bypassing the cooler, a principle similar to the cooling system in automobile engines.

All piping between engine, oil, and jacket water coolers is above ground. If the engine water has to be drained for maintenance reasons, a jacket water rundown tank has been provided. This rundown tank is large enough to hold water from several engines, coolers, and piping, thus water is conserved and waste of chemicals eliminated.

Engines are equipped with full-flow oil filters only. Oil is drawn off downstream from these filters and used in the lubricators for both power and compressor cylinders. Three of the stations are using a mild detergent oil having a naphthenic base, the other station an additive oil with naphthenic base.



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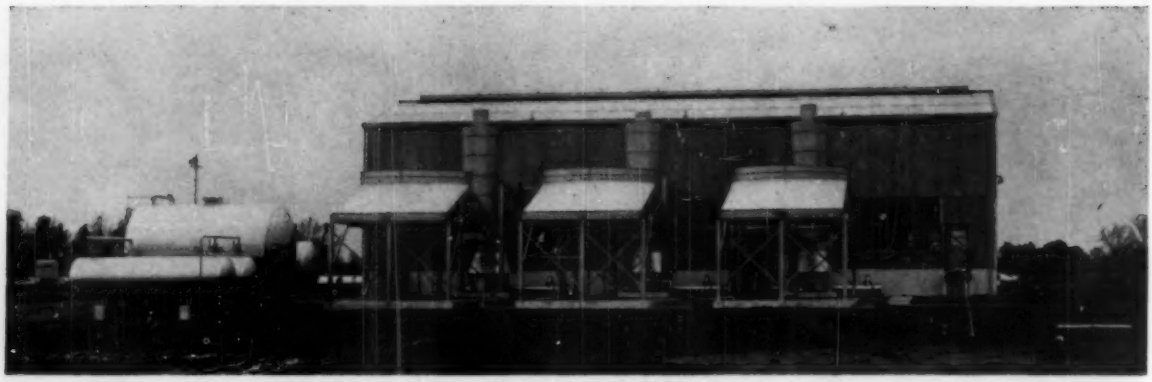

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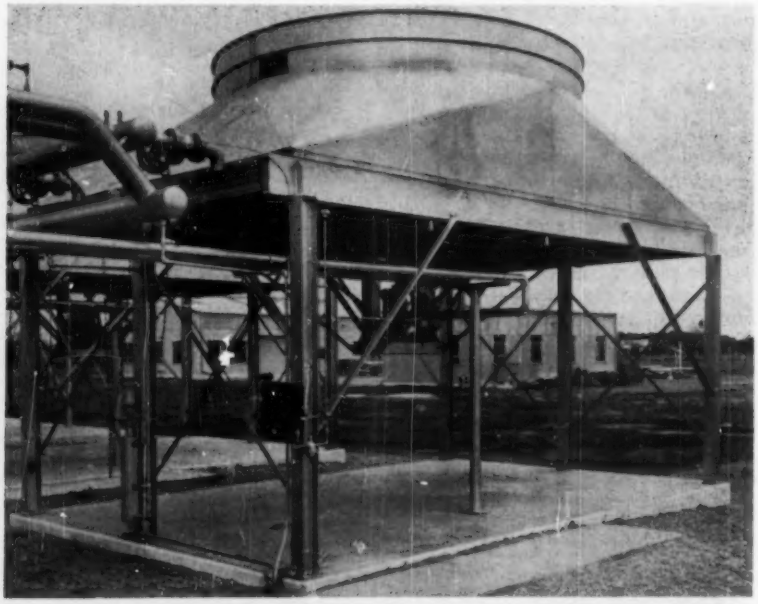

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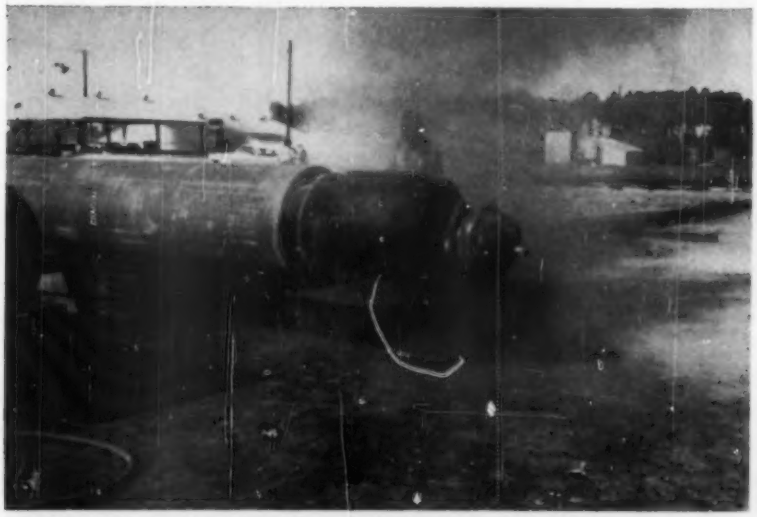

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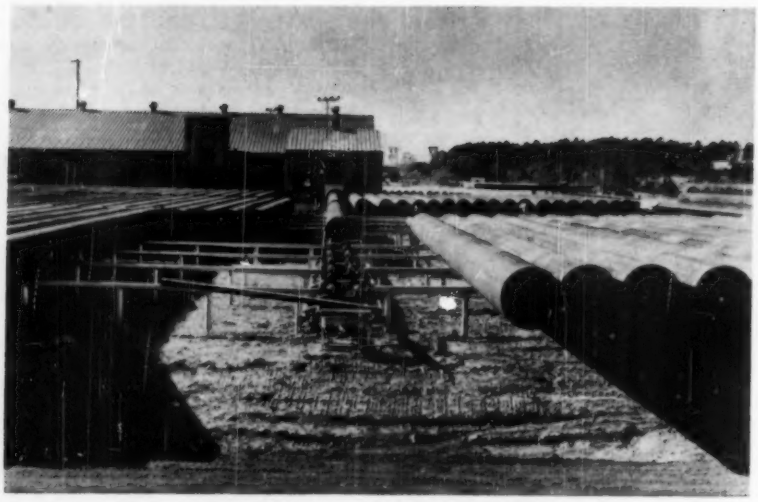

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These cooling boards, although one of the simplest parts of the installations, are one of the most important features in the plant. They are heavy concrete and steel platforms, covered with steel plate, set 45 deg from vertical. One of the racks is fixed whereas the other may be moved to accommodate varying pipe lengths. Coated and wrapped pipe is supported only on the bare ends, eliminating damage to the finished sections.

Gas-Fired Dryer

As Transco's pipe was started through the coating and wrapping process each joint passed through a gas-fired dryer to remove any moisture from the metal. This heat also helped loosen heavy scale. A grit and shot blast process prepares the pipe surface for the primer. The cleaning machine uses minute steel shot, accelerated to high velocities on the rim of a large wheel situated below the pipe, to blast mill scale, rust, and other foreign material from the steel surface, thereby preparing an anchor pattern for primer to adhere to.

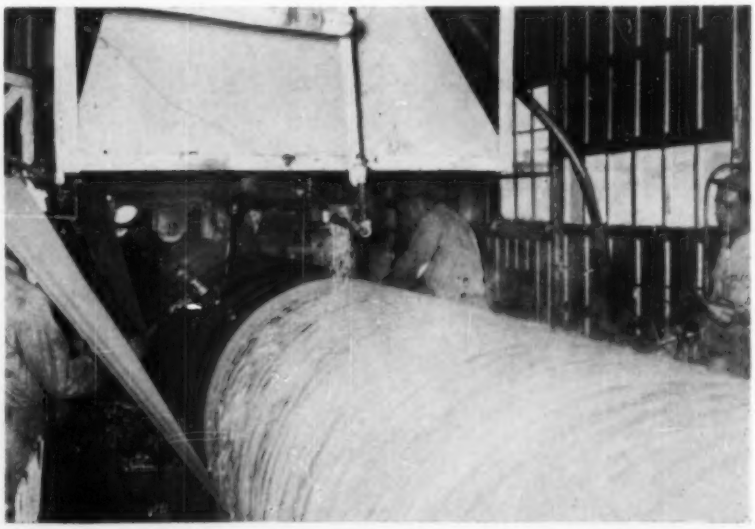
Asphalt primer was applied on a bright, though slightly matted surface, immediately behind the cleaning machine, then the primed joints were tripped onto a curing rack. These racks are in a completely enclosed and roofed room where humidity is closely controlled by gas-fired heaters and blowers. Hot air, blown through this curing room also cures the primer, from the metal outward.

Primed joints, after thoroughly curing in a dust-free atmosphere, were then gravity fed onto motor-driven endoing dollies, which moved sections through the coating and wrapping machine.

Felt outer wrap was furnished on order in 5000-ft rolls. Standard length is 400-ft. The long rolls permitted a continuous run through the coating head with a minimum number of shutdowns to change spools.

Enamel was chopped from containers in a roofed, concrete-floored platform, and the small chunks of cold enamel dropped through chutes directly into heating kettles below. This eliminated a possible source of contamination. Workmen also could add enamel to the supply in the pot as the hot material was used without shutting down the kettles and waiting for the dope to heat.

Coated and wrapped joints were jeeped after they were tripped onto the cooling racks with a special electronic holiday detector constructed for this plant. The "jeep" indicated holidays in the usual manner — a loud buzz as well as an angry snap from the electrode when current hit bare metal, but, in addition, dials were installed on the equipment to indicate at all times the exact voltage and amperage the machine delivered. ★ ★ ★



Coating was to a minimum thickness of 4/32-in. reinforced with glass fiber and wrapped with felt and kraft paper.

Underground Corrosion and Methods of Control

PART 5

O. C. Mudd, *Consulting Engineer, Alpine, Texas*

CATHODIC PROTECTION

The fundamentals of cathodic protection were stated in the discussion of electrochemical cells, viz., by the control of current flow to establish and maintain a cathode over the entire structure surface exposed to the corrosion elements of the soil electrolyte.

Such cells involve modifications of the usual laboratory cell of equal or near equal electrode surface areas, as most cathodic protection installations have cathode areas many times that of the anode and the ratio of these areas depends upon a number of factors that vary with each installation. The basic factor, however, is to establish as extensive a cathode surface as possible with a minimum of anode surfaces at the lowest practical cost of installation and subsequent operation (Fig. 11).

The extent of a cathode surface and the degree of effectiveness is determined by measurement of the voltage between structure and soil. This voltage difference must exceed that of any voltages of reaction between soil chemicals and structure metal in establishing complete protection, and this voltage will vary according to the metal and its environment.

Tests and experience have demonstrated that low carbon steel in normal soil suffers no apparent corrosion when the cathode surface is maintained at a potential 0.3 v negative to the contacting soil.

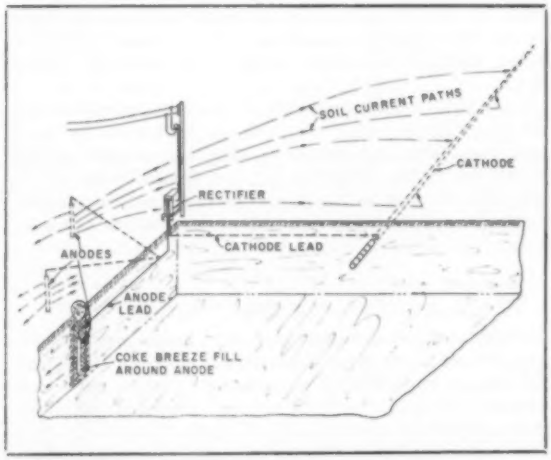


FIG. 11. Illustrating installation of a generated power unit.

This normal protection potential measured between structure and soil, with a copper sulfate soil contact electrode, is about equivalent to 0.3 v negative when the instrument indicates 0.85 v negative or 0.58 v negative when using a calomel electrode.

It is seldom practical, or economical, to establish a uniform cathode-to-soil potential along extensive structure surfaces, hence it is common to have abnormal potentials opposite or near the anode installation. Such potentials cause waste of energy and may even cause damage to the structure coating. Also, there have been indications of hydrogen embrittlement of metals where protective voltages were high.

Protective voltages maintained below the water decomposition voltage for the metal and environment will minimize energy waste and likelihood of other damage by excessive hydrogen liberation. Structures having protective voltages not exceeding 3.0 v negative to soil (with copper sulfate electrode) are not known to have suffered damage attributed to excess gas liberation.

Current requirements in establishing complete protection on underground structures depend upon the amount of the metal surface in contact with the soil. Thus it is evident that surfaces with no coating require more than those with some degree of coating whereas well-coated lines require very little.

Conditions have been encountered where soil was of a type restricting current flow below that necessary to establish a satisfactory cathode condition on the adjacent bare pipe surface. In other types, such as dense clays, that have a high degree of shrinkage with loss of moisture, part of the soil-to-metal contact is lost during dry periods and uncoated pipe has had leaks occur along the side even when the measured pipe-to-soil potential was more than 0.3 v negative.

Uncoated lines in highly corrosive soil may require amounts of currents that justify raising and coating. Tests have been conducted on a 10-in. line where 6 amp were required for each 100 ft of line, or approximately 20 milliamperes per sq ft of metal surface.

The other extreme is found with well-coated lines. Protection has been accomplished on 30 to 40 mile lengths of 20 to 24-in. diam lines with only a few amperes.

Practical application of cathodic protection for extensive underground structures resolves into determining current requirements and the most favorable locations for anode installations, with available power supply at or near these points established by tests.

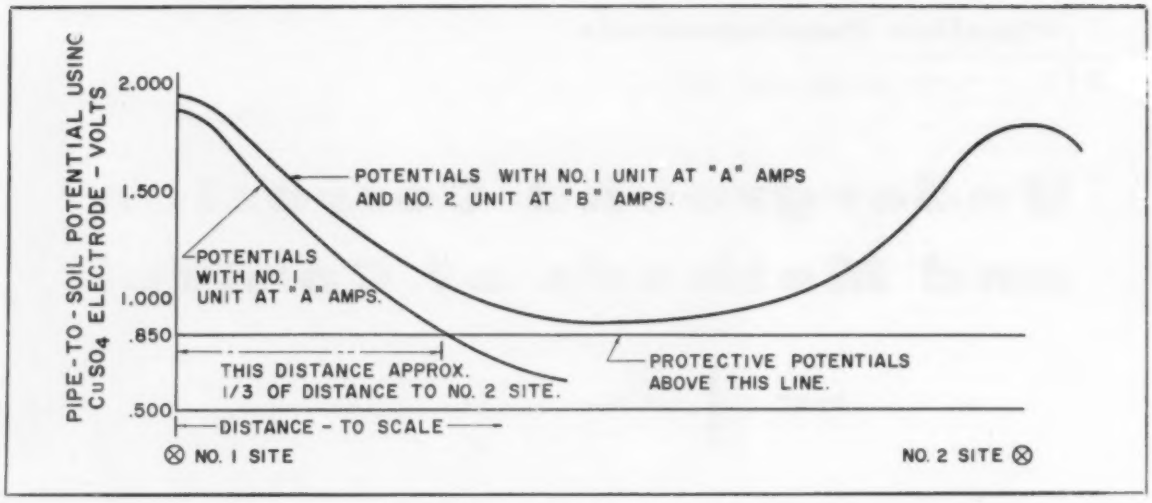

PIPE-TO-SOIL POTENTIAL USING CuSO4 ELECTRODE - VOLTS
2.000
1.500
1.000
.850
.500
POTENTIALS WITH NO. 1 UNIT AT "A" AMPS AND NO. 2 UNIT AT "B" AMPS.
POTENTIALS WITH NO. 1 UNIT AT "A" AMPS.
THIS DISTANCE APPROX. 1/3 OF DISTANCE TO NO. 2 SITE.
PROTECTIVE POTENTIALS ABOVE THIS LINE.
DISTANCE - TO SCALE
NO. 1 SITE
NO. 2 SITE

FIG. 12. Illustrating protective unit spacing tests.

Approximate points of connection for current supply can be determined by first selecting the most accessible source of controllable d-c supply and establishing an initial test site. With the negative terminal connected to the structure and the positive terminal to a temporary ground bed, pipe-to-soil potential measurements can be made to approximately the next adjacent site. This second test unit operating simultaneously with the first is necessary to verify proper unit installation spacing and current requirements from each (Fig. 12). Isolated sections, well coated, or small compact structures, may require only one site to accomplish the desired results.

Tests should be made at a current output that establishes the desired pipe-to-soil potential half way between these two sites, or at the extremity of a single site section, and continued until a constant current output shows no further cathode potential increase and the measured potentials at intervals along the entire section are adequate for protection. Well-coated lines will attain stable potentials within a few minutes, whereas poorly coated or bare lines require several hours.

Tests on new lines may give erroneous results if the backfill is not completely settled and units predicated on such early tests should be capable of providing additional current supply.

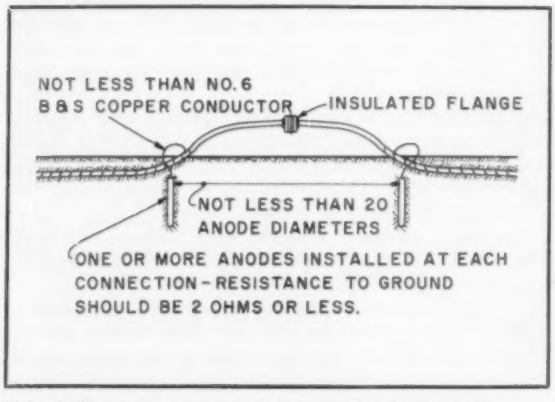

NOT LESS THAN NO. 6 B&S COPPER CONDUCTOR
INSULATED FLANGE
NOT LESS THAN 20 ANODE DIAMETERS
ONE OR MORE ANODES INSTALLED AT EACH CONNECTION - RESISTANCE TO GROUND SHOULD BE 2 OHMS OR LESS.

FIG. 13. Illustrating surge current bypass with galvanic anodes.

CURRENT SUPPLY

Current supply for cathodic protection must be constant to be effective and it is also advantageous to have means of varying current output.

The two most practical present sources are from:

1. Galvanic anodes.
2. Generated power.

GALVANIC ANODES

Galvanic anodes most prevalent in use are basically made from magnesium or zinc. These anode materials buried in soil for protection of low carbon steel give an average terminal voltage difference of:

Magnesium to steel	1.1 v
Zinc to steel	0.35 v

A more recent magnesium alloy provides a slightly higher terminal voltage, but their continuing performance at this voltage will have to be verified through use.

The low voltage difference between steel and these galvanic anodes materials limit their use for extensive protection installations where current requirements are large; however, there are many locations where galvanic anodes offer marked advantages and economy when installed alone or in combination with generated power units.

Protection of structures remote from generated power, and particularly where corrosion is limited to localized areas, may be accomplished by installing galvanic anodes and the probable economics of such installations can be calculated from the available current in the anode material.

Current output from a pound of magnesium and zinc, completely oxidized,

Magnesium	999.9 amp-hr
Zinc	371.9 amp-hr

Magnesium has the advantage in available energy; however, the efficiency in actual service falls below that listed above but it generally will supply more current per pound than zinc. On an average the latter shows higher efficiency when oxidized in the soil.

In general it is preferable to use magnesium where greater amounts of current are required for large cathode

areas, and zinc may have advantages where cathode areas are small and low potential gradients are desirable.

Galvanic anodes serve a useful purpose in new well-coated line construction when installed and attached to the line test leads (for future testing) immediately after lowering in and backfilling. This temporary protection can be made fully effective and thus arrest any start of corrosion if coating abrasions exist or develop, thus maintaining the coating in the most favorable condition for subsequent protection by generated power unit installations. Such temporary anode installations should be rechecked for effectiveness if they have to continue in service more than several months or a year.

Most galvanic anodes in soil suffer current output decline with time due to the formation of oxidation products at the anode surface. These products vary with soil chemicals. Encasing the anode in bags filled with specially prepared mixtures of chemicals and selected clays, prior to installation, helps in sustaining current output.

Magnesium in normal temperature natural salt water retains output activity when the oxidation products can drop from the surface, but zinc, in similar solutions, often becomes passive because of tighter adherence of oxidation products to the surface.

Galvanic anodes in soil or solutions at elevated temperatures can reverse polarity, hence it is advisable to check the polarity when installed and frequently thereafter where higher temperatures occur or prevail.

Galvanic anodes may be used to alleviate lightning or power originated surges across insulated segments of protected structures (Fig. 13). Such installations are most satisfactory when the terminal voltages between pipe and anode are nearly equal, as this minimizes formation of oxidation or cathode products on the anode surface that may increase surface resistance. It is essential that such installations have adequate moisture at the anode surface to conduct heavy surge currents without generating steam, which may expel the anode from the soil. This expulsion has occurred from a lightning surge where the soil moisture content was low.

Properly installed galvanic anodes have been applied in the control of stray currents to and from other structures; however, such installations are not recommended unless they can be checked frequently by well qualified personnel capable of controlling the installations to obtain the desired results.

When extensive ground beds are necessary savings can be effected in current demand by the use of suitable galvanic anode metal in place of normally used iron or copper clad rods as these latter bare metal surfaces, which usually are interconnected with the protective current system, may divert elsewhere appreciable amounts of needed current, or impose extra load on the protective unit.

Such ground beds associated with cathodic protection installations should have a terminal potential equal or slightly higher than the protected underground structure in the near vicinity.

It is evident that galvanic anodes have an economic place in providing cathodic protection under some conditions and also contribute benefits in conjunction with power generated protective installations.

GENERATED POWER INSTALLATIONS

Generated power sources are most desirable when higher voltages are necessary to obtain required current flow. Origin of this generated power may be from several sources, viz., small engine-driven generators, wind-driven generators, thermoelectric units, central generating systems, and other less common sources.

Of those mentioned the central power generating system

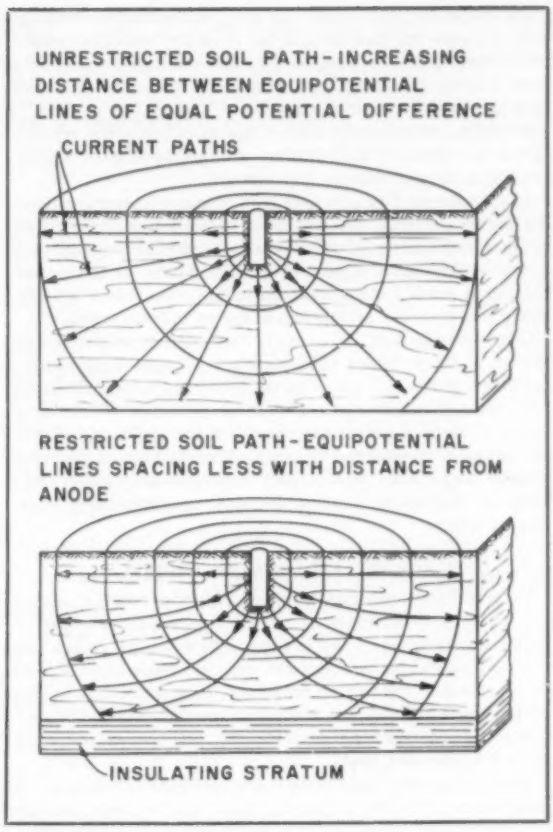

UNRESTRICTED SOIL PATH - INCREASING DISTANCE BETWEEN EQUIPOTENTIAL LINES OF EQUAL POTENTIAL DIFFERENCE
CURRENT PATHS
RESTRICTED SOIL PATH - EQUIPOTENTIAL LINES SPACING LESS WITH DISTANCE FROM ANODE
INSULATING STRATUM

FIG. 14. Anode current flow paths.

offers the most dependable source to date; however, recent developments in thermoelectric units may provide desirable power sources under some circumstances.

Generated power from central systems is predominately 60 cycle alternating current and this requires rectification to supply direct current for cathodic protection purposes.

Rectifiers are made in various types but the type most commonly used for protective current sources are known as "contact" types. These incorporate the properties of certain solid materials that allow easy flow of current in one direction and restrict it in the opposite direction.

Those materials presently in common use for this purpose include germanium, selenium, and silicon. Germainium has a higher efficiency of rectification at low voltages and silicon is better suited to higher voltage units and has the advantage of being less affected by higher temperatures.

Most contact type rectifiers are susceptible to damage by moisture, hence it is necessary to provide effective shelter for units and the shelter must exclude insects, rodents, and birds, all of which have caused damage to units in the past.

The trend is toward oil immersed units because they are most effective in excluding moisture and the cooling characteristics are superior when properly designed. Also, the case can be made tight enough to exclude most other sources of unit damage. The oil in such units should be checked occasionally for moisture content (dielectric strength) and filtered or replaced when tests show need of it. Selenium rectifiers are affected by some types of transformer oil additives and oil recommended by the manufacturer only should be used.

Oil immersed unit cases and current conduction connections through the case should be pressure tested to reduce the chance of oil seepage, which mars the appearance, cuts down cooling efficiency, and may even lower the oil level until the unit may be damaged.

Rectifiers prevalently offered by manufacturers are designed for standard distribution voltage input with a wide latitude in output voltage and current.

The dependability of a unit is of primary importance and this factor depends on sufficient insulation against surge voltages, adequate cooling provisions, and effective moisture exclusion. Efficiency is second in importance, as the power demand is small for the average installation; however, efficiency may become an important factor in large units.

Single phase half wave units have the lowest average efficiency, single phase full wave units improve efficiency, and three phase full wave units further increase efficiency.

Protective installations should be provided with a unit having at least 20 percent reserve in output voltage and current because of seasonal changes affecting ground bed and cathode areas. Also, well-coated structures may suffer incidental or accidental coating damage, thus requiring additional current.

GROUND BED INSTALLATIONS

Current from rectifier units or other generated power sources must have the positive terminal lead connected to one or more anodes buried in the soil to establish an electrolytic cell in which the dissolved soil chemicals serve as the electrolyte and the buried structure to be protected in this soil becomes the cathode. A group of anodes, interconnected, to serve in conducting current into the soil is normally termed a "Ground Bed."

Installation of ground beds is a major part of a protective installation when the magnitude of current is large, because the greater part of current flow resistance through the cell is encountered at the anode surface and through the adjacent soil. Any reduction of ground bed resistance results in a saving of power, hence it is good economy to ascertain with instruments the best location in the vicinity of a proposed unit site.

Soil resistivity measurements obtained with a four-electrode type resistivity meter at intervals of 100 ft, in a square grid pattern, usually will reveal the trend of any soil resistivity variations and allow choice of a ground bed location where the lowest resistivity soil is indicated. It is advisable to make some determinations of resistivity for varying depths to ascertain whether higher resistance strata exist at greater depth, as the existence of any such strata may restrict the current flow path and result in a higher resistance ground bed than an equivalent one where low resistivity soil continues to appreciable depths.

These variations in ground bed resistance can be visualized by considering that the current path through unobstructed soil radiates from the ground bed in a hemispherical path, whereas a shallow depth high resistance stratum confines current flow to a disk formation between the soil surface and this obstructing stratum (Fig. 14).

Charts have been prepared for ground bed resistance approximation, but these published charts assume a homogeneous uniform soil resistivity that allows unrestricted hemispherical radiation, hence their ascribed value depends upon adequate soil resistance data properly interpreted.

In some locations low resistivity soil exists only at some depth below the surface and drilled anode holes may be justified by the power savings to be realized over that of a shallow depth installation. Drilled hole anodes should include gas venting unless the anodes are below water level.

Anodes of various conducting materials have been used in the past, but most of these were made up from junk steel pipe or cast iron. Various chemical-metal-combinations have been devised, but maintenance of such cell electrodes posed a problem.

Recognition of the low anode loss rate of carbon type electrodes, particularly in graphite form, brought this material into use. One ampere-year gives a calculated loss of approximately 2 lb.

More recently a high silicon cast steel has become competitive with carbon (graphite) anodes and their relative values will be manifest only after extended periods of service in various environments.

Low resistance insoluble materials, such as coke breeze, intermediate between small diameter anodes and soil, contribute in lowering resistance to the adjacent soil.

The pattern of anode locations in a ground bed frequently is determined by soil conditions but where the soil is near homogeneous with respect to resistivity, some geometric pattern is favored. Some patterns can be designed which tend to equalize anode current distribution. The basis of one such design is the modification of equal segments of a circle to form a triangle (Fig. 15).

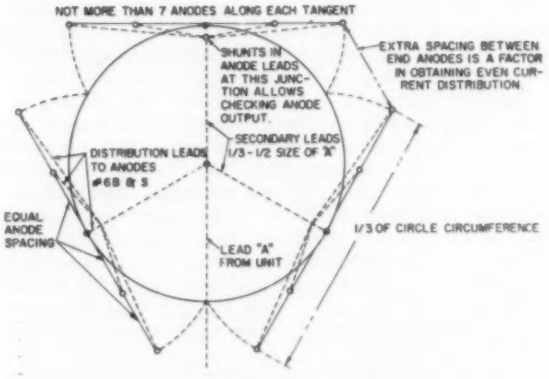

NOT MORE THAN 7 ANODES ALONG EACH TANGENT
SHUNTS IN ANODE LEADS AT THIS JUNCTION ALLOWS CHECKING ANODE OUTPUT.
EXTRA SPACING BETWEEN END ANODES IS A FACTOR IN OBTAINING EVEN CURRENT DISTRIBUTION.
SECONDARY LEADS 1/3 - 1/2 SIZE OF "A"
DISTRIBUTION LEADS TO ANODES #6B & S
EQUAL ANODE SPACING
LEAD "A" FROM UNIT
1/3 OF CIRCLE CIRCUMFERENCE

FIG. 15. Ground bed layout providing near equalization of anode current.

UNDERGROUND CONNECTING CONDUCTORS

Connecting conductors between structures and galvanic anodes are not subjected to the higher voltages encountered in power source installations. These connections are always negative to the surrounding soil, hence the type of insulation on the conductor is of minor importance. Vinyl insulation (TW) has given satisfactory service for such installations.

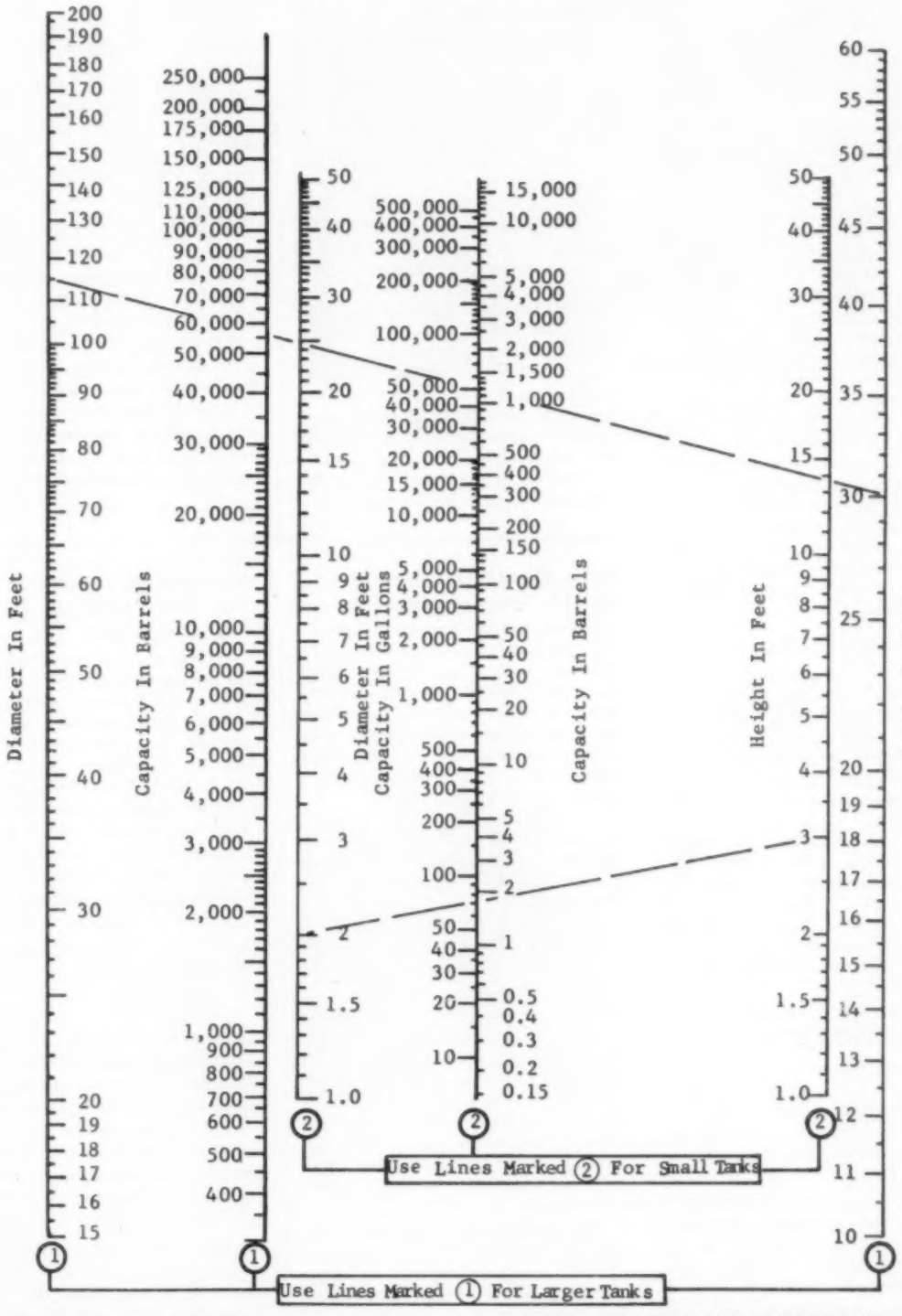
Conductors for installations of higher voltage require insulation having an extremely low M.V.T. rate to avoid electrolytic damage to the positive terminal lead between the unit and ground bed, or hydroxyl ion concentration within the negative lead insulation. Insulation composed of polyethylene adjacent to the conductor, with an exterior vinyl sheath for abrasion resistance, has given good service.

Buried connections, particularly in the positive circuit, must be protected against moisture intrusion. Several layers of polyethylene tape, carefully applied, have been fairly effective, and the covering of underground connections with no less than 1 in. of hot poured bitumen has given excellent results.

The exclusion of all air from under any applied insulation over connections reduces the chance of moisture intrusion.

(To be concluded in an early issue)

TANK CAPACITY CHART



Note: For Approximate Calculations.

Chart Courtesy Graver Tank & Manufacturing Co., Inc.

Pipeline Projects

TGT Shows Gas Supply In Latest Filing To Enlarge System

A new high of approximately 18 trillion cu ft of gas reserves dedicated to Tennessee Gas Transmission Company's pipeline system has been reached through addition of 3.2 trillion cu ft of new gas, according to the company's newest application to construct a $46,206,000 system enlargement.

This new application before the Federal Power Commission, superseding one filed January 18, calls for the construction of 191 miles of 30 and 36-in. pipeline parallel to the existing system in Kentucky, Ohio, Pennsylvania, and New York, and 43,600 compressor hp to be installed in five new stations in Mississippi, Alabama, Kentucky, and New York, plus four existing stations.

In line with a recent FPC requirement that the company make a full gas supply showing in its next system expansion application, it submitted as exhibits a total of 81 new gas purchase contracts and amendments to existing purchase contracts plus reserve estimates of its own production.

The new facilities would be used to supply up to 160,000,000 cu ft of additional gas per day to 46 of the firm's existing customer companies at delivery points from Mississippi to northern New England.

Applies For LPG Line

Application for permission to lay a 125-mile LPG pipeline across central Alberta from the Westerose South wet gas field to underground storage facilities at Hughenden on the east side of the province has been made by Hughenden Pipeline Ltd., an Alberta company.

The British-American Oil Company Ltd. is building a conservation and extraction plant in the field where wet gas by-products, principally propane and butane, will be produced and purchased by Alberta Underground Storage Ltd. which operates the reservoir at Hughenden.

Examiner OKs Imports Into Pacific NW but Stipulates Annual Disclosures

Ruling that the Federal Power Commission must search out latent dangers to consumer interests and provide adequate safeguards to protect consumers, FPC presiding examiner Robert M. Weston has approved, but stringently conditioned, a vast interconnected pipeline project designed to bring an average of 584,500,000 cu ft of natural gas per day from fields in Alberta, Canada, into the United States for ultimate consumption in California and the Pacific Northwest states.

The decision, subject to full FPC review, authorizes three U. S. companies—Pacific Gas Transmission Company, El Paso Natural Gas Company, and Montana Power Company—to import approximately 213.3 billion cu ft of gas annually for ultimate consumption principally in California, and also in Oregon, Washington, Idaho, and Montana, but provides for full publication of facts of profits and prices in annual reports to be made to the FPC. Weston also reserved for further showing the amount of return to be approved on new capital invested in the project.

Examiner Weston declared that if the annual reports filed by the U. S. companies, including complete data on the Canadian companies' operations, indicate the existence or possibility of excessive costs in the Canadian components of the project, further action may be taken by the FPC and the local authorities in the U. S. areas to be served to induce representation on behalf of U. S. consumers to the appropriate Canadian authorities.

The annual reports which the three U. S. companies must make for all of the Canadian companies would include field price information, financial statements, cost of delivered gas, revenue and volume figures, tax accruals, new construction, and copies of new or revised gas purchase contracts.

Plans Outlet Gas Line For 12 Texas Counties

Texas Southwestern Gas Corporation, a new company, plans to build a 100-mile natural gas pipeline from Coleman County to Jack County, Texas, to provide an outlet for numerous shut-in wells in Brown, Coleman, Comanche, Callahan, Eastland, Erath, Jack, Palo Pinto, Parker, Stephens, Young, and Wise counties.

A processing plant with a capacity of 100,000,000 cu ft per day also is planned in the Eastland-Ranger area.

Total cost of facilities is estimated at $30,000,000.

Construction will start as soon as the company has commitments for 100,000,000 cu ft per day, according to the announcement.

Mid-America Operation May Offer Set-Back To Proposed Export Line

An ambitious project for a $150,000,000 pipeline system to transport future excess wet gas by-products from Foothills region gas fields to the Chicago area has been placed before the Alberta Conservation Board by Foothills Products Pipe Lines Ltd., a subsidiary of Pembina Pipe Line Ltd.

The most serious problem facing the proposed line from Canada is the Mid-America pipeline that, by next winter, will be transporting products from the Southwest to Minneapolis, Minnesota, and Madison, Wisconsin, giving it an advantage of a year or two toward absorbing the same market.

The prospect of about 85,000 bbl per day surplus propane, butanes, and natural gasoline being available in Alberta as soon as the major wet gas export pipeline goes into operation prompted Foothills to propose the line. It would run from the Alberta-Saskatchewan boundary southeastward, crossing the international border near Estevan and following almost a straight line through Minneapolis to Chicago.

It would be served by a large province-wide Alberta gathering system.

An American subsidiary would operate the U. S. portion of the line.

INTERNATIONALLY . . .

Saudi Arabia is getting its largest diameter pipeline — a 34 through 36-in. crude oil line 17½ miles in length being built by Arabian American Oil Company between Qatif Junction and Ras Tanura.

In Brazil a new 32-mile pipeline now links three new oil fields — Buracica, Cassarongongo, and Taquipe, in the Reconcavo of Bahia — with the Candeias-Madre de Deus system.

In planning the 160-mile Indonesian crude oil pipeline from the Tandjung oil field to Balikpapan, the Royal Dutch/Shell Group announces that it has found it possible to obviate the use of costly heating equipment by pumping the very waxy crude oil produced from this field as a suspension in water. Thus the temperature can remain considerably lower than would otherwise be necessary.

The Syrian government's two planned 6-in. products lines — one running 110 miles north to Aleppo from the new Homs 20,000-bbl-per-day refinery, and the other 95 miles south to Damascus — will cost $5,600,000.

Bid Dates Announced On Montana-N.D. Line

Bids will be taken about June 1 on the construction of the 200-mile, 8-in. products pipeline planned by Farmers Union Central Exchange, Inc., between Glendive, Montana, and Minot, North Dakota. The project also includes a terminal at Minot, for which bids will be taken about June 15.

The announcement came from Pipe Line Technologists, Inc., engineer of the project.

The line is an extension of the Oil Basin Pipe Line Company system, which at present runs from Laurel to Glendive and is connected to the Farmers Union Central Exchange refinery at Laurel, Montana.

New Filings Involve 78 Mi., River Crossing

Three unrelated construction applications have been filed with the Federal Power Commission involving about 78 miles of large diameter pipeline and a dual crossing of the Mississippi River. Combined cost is about $10,830,370.

Equitable Gas Company proposes to construct between now and 1962 approximately 32 miles of 16-in. and 27 miles of 20-in. pipeline in West Virginia and Pennsylvania at an estimated cost of $5,384,070 to increase its system capacity by 76,000,000 cu ft daily.

Columbia Gulf Transmission Company's application involves a dual 24-in. crossing of the Mississippi River near Lake Providence, Louisiana, at an estimated cost of $3,500,000, to replace the existing crossing now located about 1½ miles to the south. Changes in the river necessitate the new construction, the company states.

Atlantic Seaboard Corporation plans to construct about 13 miles of 26-in. and about 6 miles of 20-in. loops, costing approximately $1,946,300, in Virginia and Maryland, to increase its Cobb-Baltimore pipeline capacity.

HP Boost in Bisti Gets Temporary OK

El Paso Natural Gas Company's application to add compressor horsepower on its Bisti field area gathering system in the San Juan Basin of New Mexico has received a temporary certificate from the Federal Power Commission.

The additional 3470 hp will be installed in various size units at various locations as may be required at a cost of $1,454,000 and will enable the company to take up to approximately 17,000,000 cu ft of casinghead natural gas per day from producers in the field. These volumes are in addition to the total of 25,000,000 cu ft daily involved in another proceeding.

BIG Parsons® 420 Trenchliner...

Digs 36 to 52 in. wide... 7½ FEET deep

Today you'll find the right answer to your cross-country work and other big trenching jobs in Parsons 420 Trenchliner®. Developed especially for big work schedules, it has the extra capacity, performance and dependability you need to open trench at lowest cost per lineal foot.

Digging from 36 to 52 inches wide at depths to 7½ feet, this heavy-duty wheel-type machine produces up to 25 lineal feet of trench per minute. With all this extra capacity you still get smooth, precision wheel control. Double-action hydraulic rams actuate digging wheel — give infinite depth selections, maintain close grade tolerance in toughest digging. Heavy-duty wheel has formed steel-plate buckets, solid or tine-back, with replaceable point-type teeth.

Hydraulic control system on conveyor gives belt speeds up to 621 feet per minute — *completely independent of digging wheel speeds.* Belt easily handles maximum yardage from the extra-wide wheel — puts spoil bank well back beyond edge of trench. See Parsons distributor, or write for more facts.

Need deeper trenches on your cross-country work? Then check this larger companion model 520 Trenchliner. It produces up to 28 lineal feet of trench per minute — 40 to 52 inches wide at depths to 8½ feet. Parsons offers a complete line of wheel and ladder-type Trenchliners. In addition to the 420 and 520, there are 3 smaller wheel types — and a choice of 5 heavy-duty ladder type Trenchliners.

Mail to: PARSONS COMPANY, NEWTON, IOWA *Send literature on:* ☐ 420 Trenchliner ☐ 520 Trenchliner

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COMPANY_____

DIVISION_____

STREET_____

CITY, STATE_____

(A Division of Koehring Company) P932 PE

TRENCHLINERS for PIPELINERS

Interstate To Build New, Modern Station

Interstate Oil Pipe Line Company, to keep pace with expanded production in fields south and east of Raceland, Louisiana, served by its systems, has announced plans to replace its present Raceland station which, since constructed in 1943, has grown from 3 to 11 gas engine driven pumping units.

The new station will have two electric motor driven pumping units with a combined horsepower of 2400. Pumping capacity will be 105,000 bbl per day. Additional pumping units may be installed to further increase the station capacity to provide for new production which may be developed in the area served.

Construction by Interstate personnel under the supervision of O. B. Denny, acting district superintendent, is scheduled to begin immediately, with completion planned about September 1, when its operation will be placed under the supervision of E. W. Bergquist.

The new station, which will pump direct to Interstate's terminal at Anchorage, Louisiana, across the Mississippi River from Baton Rouge, will include some of the latest and most modern auxiliary equipment such as safety features and automatic devices and can be operated unattended.

"Budget" Construction: 2 OK'd, 2 Filed

Two budget-type applications involving $5,500,000 in construction have received Federal Power Commission authorization, and two others have been filed.

Transcontinental Gas Pipe Line Corporation was authorized to construct facilities from time to time during the 12-month period following authorization, at a total cost not in excess of $3,000,000, with the cost of any single project limited to $500,000.

Columbia Gulf Transmission Company received FPC authority to construct facilities during 1960 at a total cost not in excess of $2,500,000, with single projects limited to $500,000.

New applicants were **Texas Gas Transmission Corporation** and **Michigan Wisconsin Pipe Line Company,** both proposing facilities whose total cost would not exceed $3,000,000 and single projects not to exceed $500,000.

Texas Gas would build its facilities during the 12-month period beginning May 30, and Michigan Wisconsin during the 12-month period following authorization.

Seeks to Lay Avi-Gas Line

Trans-Prairie Pipelines Ltd. has applied to the Alberta Conservation Board for permission to lay a 16-mile, 3-in. products line to transport aviation gasoline from the Edmonton refinery area to the Nisku airport which is now in early stages of development south of Edmonton.

The proposed line would cost an estimated $800,000.

FPC Throws Out Protest On Rock Springs Project

Green River Basin Corporation, gambling for time to develop plans for a natural gas pipeline to serve the Green River Basin of Wyoming, has been notified by the Federal Power Commission that its "informal protest" cannot be considered because it is not an intervenor in connection with an application, known as the Rock Springs project, the FPC is now considering from El Paso Natural Gas Company and Colorado Interstate Gas Company.

Green River Basin Corporation asked the FPC to consider the entire basin as a unit and to give gas producers there a chance to share in any pipeline system that would be necessary to move the gas.

Proved reserves of the basin have been estimated by others at about 6 trillion cu ft. Most of this gas has been dedicated to El Paso Natural, which has a line through the basin from Pinedale and Big Pine fields.

Alaska Crude Oil Line To Get Underway Soon

Work on a 20-mile crude oil pipeline on Alaska's Kenai Peninsula will start as soon as right-of-way arrangements are concluded, according to an announcement by Standard Oil Company of California, Western Operations, Inc.

The project, to be owned by a newly-formed operating affiliate, Kenai Pipe Line Company, will include an 8-in. line to a new marine terminal at Nikiski on the Cook Inlet 20 miles to the west of the producing area, as well as pumping stations and feeder lines in the Soldotna Creek and Swanson River Unit oil fields.

Total cost will be more than $4,000,000 and completion is scheduled by mid-1961.

Principal engineering problem will be construction, scheduled to begin in several weeks, of the marine terminal on the Cook Inlet. Excessive tidal action there produces tidewater velocities of up to seven knots and water level variations of 25 ft.

PIPELINE PERSONALS

H. T. Heuple

▸ **New transmission superintendent** for Pittsburgh Group Companies of the Columbia Gas System is **Harry T. Heuple.** Assistant transmission superintendent since 1955, Heuple succeeds **R. E. Grant** who retired recently after 43 years of service.

▸ **Named recipients** of the A. F. Davis Silver Medal for 1959, in recognition of their contribution to the advancement of industrial welding by the American Welding Society, are two Service Pipe Line Company executives. They are: **Art M. Hill,** superintendent of line maintenance, who has been associated with welding and pipeline construction for 40 years; and **Fred W. Zilm,** contracting administrator, a 26-year veteran with Service who has been a leader in developing new welding processes in the pipeline industry. Hill and Zilm are co-authors of a paper entitled "Maintenance Welding of High Test Line Pipe."

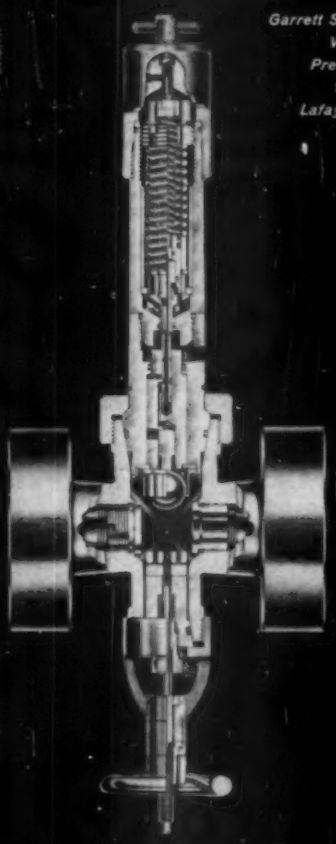
▸ **New market consultant** to the ASCOP division of Electro-Mechanical Research, Inc., is **W. T. Bulla,** recently retired director of operations for Natural Gas Pipeline Company of America and affiliates.

▸ **Creating new positions** of chairman and vice chairman, Northern Natural Gas Company's board of directors has elected **John F. Merriam** and **Max A. Miller** to the posts, respectively. Merriam is also serving as president, a position he has held since 1950. Miller has been a director of Northern for 17 years.

▸ **Joseph L. Seger,** president of the Carter division, Humble Oil and Refining Company, has transferred to the parent Humble company in Houston, Texas, as vice president for public affairs (public relations and government relations), and **John W. Brice** has resigned as executive vice president of Humble to become president of the Carter division with headquarters in Tulsa, Oklahoma. Prior to the merger of Carter and other major domestic operating affiliates of Standard Oil Company (N.J.) into the Humble company several months ago, Brice was president and Seger executive vice president of Carter Oil Company.

▸ **Engineers promoted** by Service Pipe Line Company in its West Texas division and district offices include **Robert H. Grimes, Jr., Merlin T. Bender,** and **Dale Burton.** Grimes, former oil traffic engineer at Lubbock, Texas, was advanced to engineer, senior grade, replacing **C. F. Simes** who recently was promoted to district superintendent at Lovington, New Mexico. Bender, former engineer in Lovington, replaces Grimes. Burton, former engineer, junior grade, in Tulsa, Oklahoma, is Bender's replacement.

▸ **Atlantic Pipe Line Company** announces that **Paul A. Fowler, Jr.,** is new administrative assistant and that **Rogers B. Samford, Jr.,** replaces him as chief dispatcher. **Frank A. Billiott,** the company's district foreman in Crockett County, Texas, has been named regional material man at the Atreco terminal.



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World's Highest
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13,000# Shut-in
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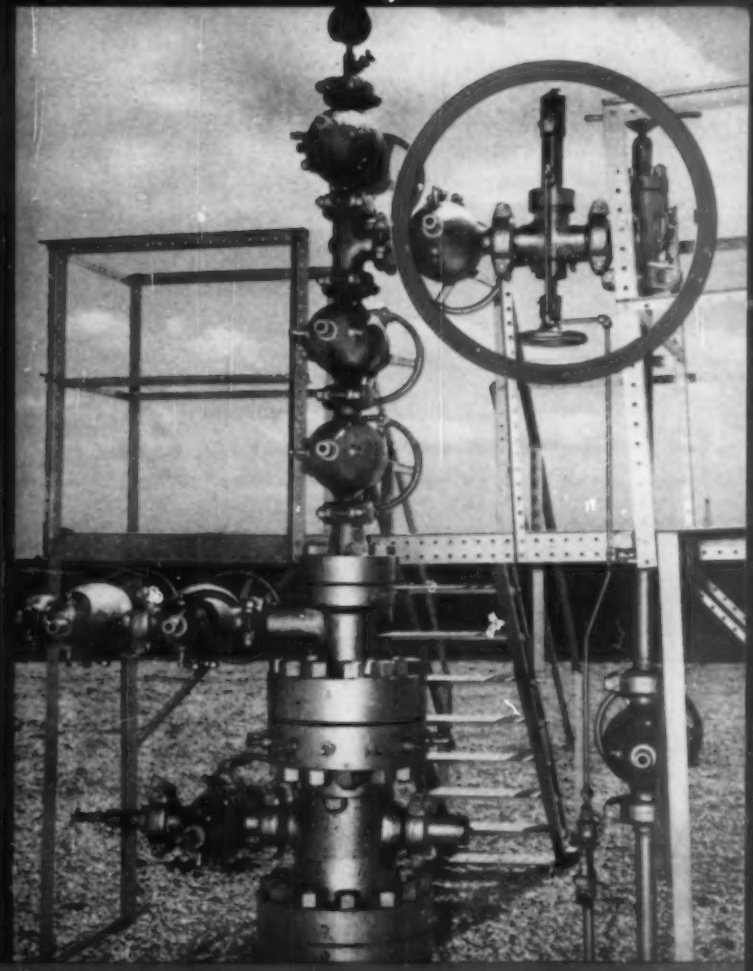

GARRETT SAFOMATIC SELECTED

FOR WORLD'S HIGHEST PRESSURE WELL

Another GARRETT-ENGINEERED product

Union Texas Natural Gas Corporation's #1 Adams in South Louisiana recorded a seam straining 13,000 psi shut-in wellhead pressure. Yet, down stream lines and equipment are as safe as if they were connected to a non-flowing well.

Positive pressure control is provided by a Garrett Safomatic Valve mounted right on the tree. Should pressure exceed the preset maximum or fall below the minimum range . . . the well would be shut-in automatically. Closure is instantaneous and as positive as if the master valve were closed.

Safomatic valves can be installed on any line or equipment that needs protection. Many are used on gathering lines, heaters, treaters and other equipment. Three basic Garrett designs handle a range of pressures up to 15,000 psi.

Standard Safomatic valves operate automatically from line pressure changes. Remote operated Safomatic valves may be actuated by pressure conditions at another point in the system.

Check with your Garrett representative on the extra safety possible with a Garrett Safomatic installation.

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PIPELINE PARADE

. . . in equipment, services, sales

To aid Canadian contractors and companies, **Crose-Curran, Ltd.,** Edmonton, Alberta, has announced organization changes. Bud Glenn, formerly branch manager of the Toronto division, has been promoted to manager of operations at the company's main office, assisted by: Harvey Gordon, sales; Bob McLean, office manager; Bill Clark, heading shop and service departments. Roger Garneau was appointed office manager of the Toronto division; and Frank Munshaw, formerly of Cessco, in charge of sales and services for the Toronto area.

C. Straughan

Midwestern Pipe Line Company has moved its Atlanta office to 611-612 St. Petersburg Times Building, St. Petersburg, Florida, and announced that Clem Straughan, southeastern manager, will head the new office.

The sale of General Pacific Corporation's Hill, Hubbell Division to National Malleable and Steel Castings Company has been agreed to by both companies, subject to the approval of General Pacific shareholders. It was disclosed that the cash purchase would involve approximately $3,000,000.

To provide pipeline companies with technical advice and consulting service on the application of carrier and microwave radio, **Automatic Electric Sales Corporation** has appointed Robert E. Overby a staff engineer to be headquartered in the corporation's western district office in Burlingame, California. His appointment is part of an overall expansion program to provide better carrier and radio engineering service.

T. H. Creden

Reorganization of one of its major grouping of divisions and the appointment of three new division managers has been announced by the **A. O. Smith Corporation.** The Petroleum Group, now the Capital Equipment Group, includes the Tubular division, with Thomas H. Creden as general manager; the Atomic and Process Equipment division (formerly the Process Equipment division), headed by Warren Hendricksen; the Aero Western division; and a wholly-owned subsidiary, Glascote Products, Incorporated. A new Space-Ordnance division has been created, and H. D. Barnes has been named its general manager.

W. Hendricksen

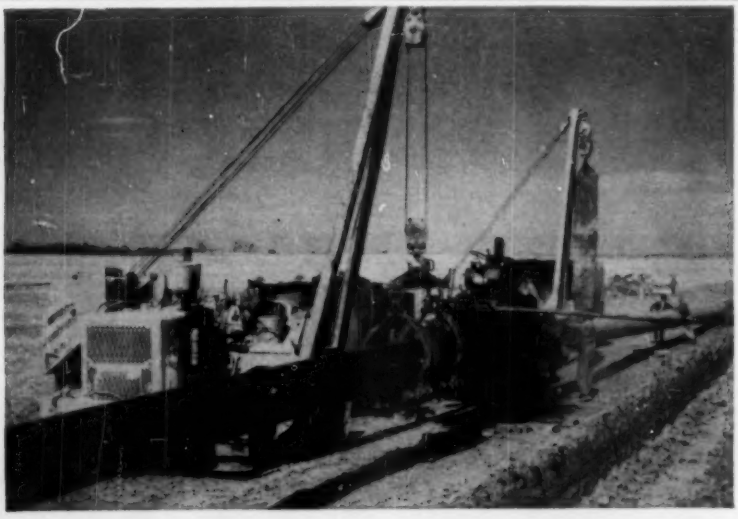
H. D. Barnes

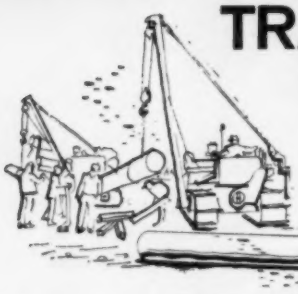
An electrical engineer in the pipeline industry, Max T. Nigh, has been appointed industrial process control representative for the **Data Processing Division of International Business Machines Corporation** in its midwestern region. Nigh, who joined IBM early this year, is past president of the Tulsa chapter of the Instrument Society of America and chairman of the Pipeline Committee of the Transportation Division.

H. R. Cabell

M. H. Jackson Pipeline Supply Company announces the appointment of Henry R. Cabell as a sales representative. He will concentrate his initial sales efforts on the distribution of the industrial rubber products of the Gates Rubber Company, which include scraper cups, V-belts, multiple V-belt drives, heavy duty sheaves, industrial hoses and couplings, molded rubber goods, and rubber lined tanks.

Cooper-Bessemer's first Canadian manufacturing effort, Cooper-Bessemer of Canada, Ltd., at Stratford, Ontario, Canada, will be headed by Harold C. Johnson, vice president, and C. W. Gilchrist, plant manager. Johnson, named vice president of the parent corporation, as well, has been manager of manufacturing for the parent company's main plants at Mount Vernon, Ohio, and Grove City, Pennsylvania. Gilchrist was formerly assistant works manager at the Mount Vernon plant.





TRANSWESTERN IS BUILDING FOR ENDURANCE!

The Transwestern Pipeline Company line, with 1600 miles under construction from Fort Stockton, Texas and the Texas Panhandle to near Needles, California, will serve West Coast consumers with natural gas for many, many years to come. Its underground lines and structures are being installed with coal-tar enamel coating for high integrity electrical insulation and life-long corrosion protection. Reilly Hot Service Enamel with HS X-10 Primer and Reilly Intermediate Enamel with Q.D. Primer have been specified along with Coal Tar Enamels of other manufacturers and will serve as the engineering material of choice for corrosion mitigation.

Reilly COAL TAR PRODUCTS

ARMED Protective Coatings

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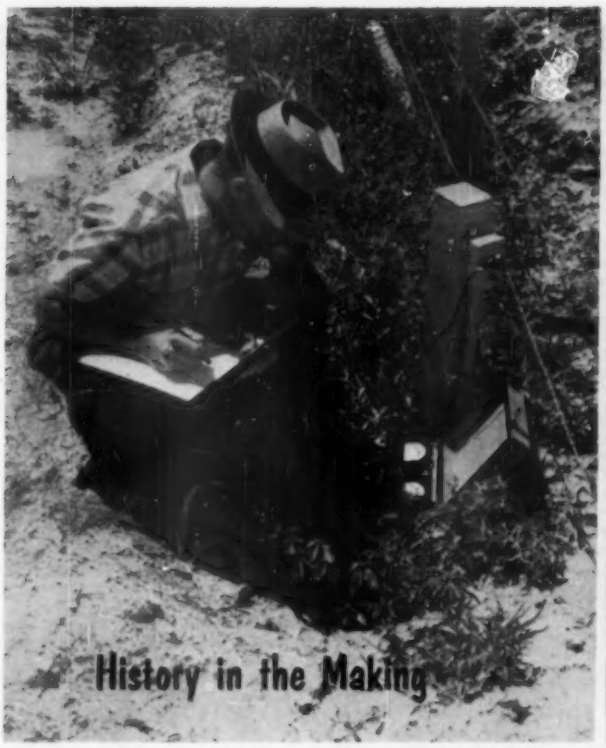

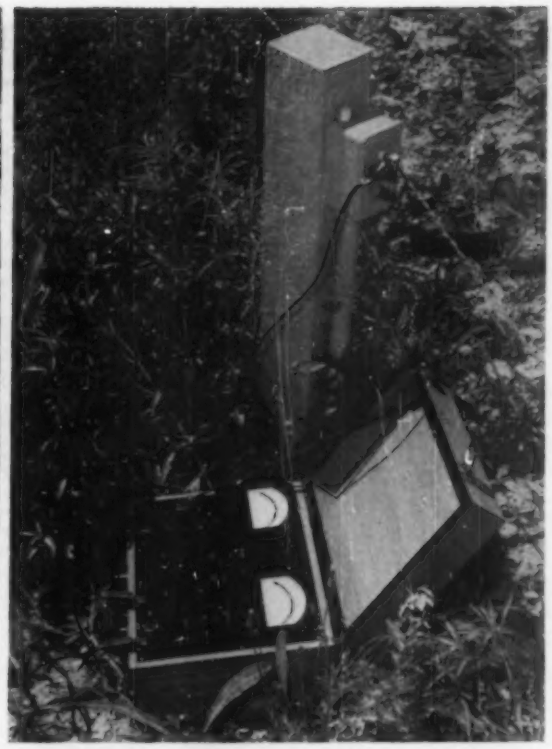

Now! Periodic Checks of Pipe Enamel Efficiency by Independent Corrosion Engineers—at Our Cost!

Gulf States Asphalt Company again makes history by offering its customers periodic checks of pipe enamel condition on the line after backfill. This inspection is conducted by leading corrosion engineers at no cost to the customer.

This service is another FIRST for the firm which provided the first and still the only Performance Guarantee covering pipe enamel and primer.

Today no other firm offers either a Performance Guarantee or periodic inspection after backfill possibly because no other manufacture. is as sure of its products as GULF STATES ASPHALT COMPANY, INC.

Buy on the basis of what's in the product and what the product will do for you and you'll buy GULF STATES. Buy on proven underground performance and you'll buy GULF STATES. Buy on periodic follow through and inspection by acknowledged unbiased experts in the field and you'll buy GULF STATES. We remove the doubts the uncertainties with performance values plus service and inspection of your line condition after backfill. Buy on the basis that you will be kept informed of your line condition from year to year.

GULF STATES No. 474 Pipe Primer and GULF STATES No. 434 Pipe Enamel — provably the Economy coating, initially and long term!

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PIPE JOINT CLAMP STOPS LEAKS
at joint where pipe is screwed into fitting

SKINNER-SEAL
PIPE JOINT CLAMP stops leaks at joints where pipe is screwed into fitting. Any temperature—any pressure up to 2,000 pounds. Saves the cost of tearing out and renewing leaky fittings. Prevents shutdowns. In stock at most oil supply stores.

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EMERGENCY PIPE CLAMPS for safe, sure, lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12" for steel and C.I. pipe. Stocked by practically all oil supply stores.

Complete line of Repair Clamps. Send for Catalog 54!

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SOUTH BEND 21, INDIANA

WITH THE PIPELINE CONTRACTORS

● **O. R. Burden Construction Corporation, P. O. Box 5216, Tulsa, Oklahoma.** Has been awarded a joint contract with H. B. Zachry Company to construct *Old Ocean Fuel Company's* 370-mile natural gas pipeline between the Gulf Coast area, south of Houston, Texas, to the Fort Worth area. Spread No. 1, consisting of 92 miles, begins at Washington County and ends at Limestone County, under the supervision of R. M. Jones. Spread No. 2, consisting of 92 miles, begins at Limestone County and ends at Fort Worth, under the supervision of C. M. Hoffman.

● **Canadian-Parkhill Pipe Stringing, Ltd., 164 Eglinton Avenue, East, Toronto, Ontario, Canada.** Is loading and hauling approximately 37 miles of 30-in. pipe in locations from Aurora, Ontario, to East Braintree, Manitoba, for *Trans-Canada Pipe Lines Limited*, and has been awarded a contract by the same company to string approximately 52 miles of 30-in. pipe from Winnipeg to Emerson, Manitoba.

● **Cape Construction Company, Box 423, Cape Girardeau, Missouri.** Has been awarded a contract by *Illinois Power Company* to build approximately 22 miles of 12, 14, and 16-in. high pressure gas lines near Belleville, Illinois, where headquarters will be located under the supervision of Trece Boyd.

● **Collins Construction Company, P. O. Box 86, Port Lavaca, Texas.** Has in progress the construction of dual 12 and 24-in. natural gas pipeline river crossings for *Petroleos Mexicanos* between Pemex City and Mexico City in Mexico. Field office is in Minatitlan, Mexico, with Rug Stapleton as project manager.

● **Contracting and Material Company, 1235 Dodge Avenue, Evanston, Illinois.** Has received a contract to construct for *Northern Illinois Gas Company* a 73-mile, 30-in. natural gas pipeline between Troy Grove and Aurora, Illinois. Field office will be at Earlville. Arthur J. Fry has been appointed superintendent.

● **Houston Contracting Company, 2807 Buffalo Speedway, Houston 6, Texas.** Has been awarded a contract by *Michigan-Wisconsin Pipe Line Company* to build 92 miles of 24-in. pipeline in Wisconsin. Headquarters will be at New London, under the supervision of R. L. Silar. Has been awarded a contract by *Shell Pipe Line Corporation* to lay 3 miles of 10-in., 3 miles of 22-in., 3 miles of 22-in. reconditioned line across the proposed Oologah Reservoir in Rogers County, Oklahoma. A. J. Slovak will supervise, and Claremore will be the site of the field office.

● **Hunsaker Trucking Contractors, Inc., Box 97, Carrollton, Texas.** Has been awarded stringing contract on the *Old Ocean Fuel Company* natural gas pipeline between the Gulf Coast area, south of Houston, Texas, to the Fort Worth area. Is working on 70 miles of 16-in. and 25 miles of 20-in. for H. B. Zachry Company between Graham and Fort Worth. One field office is located at Springtown under the supervision of Buster Cooper, and another at Fort Worth

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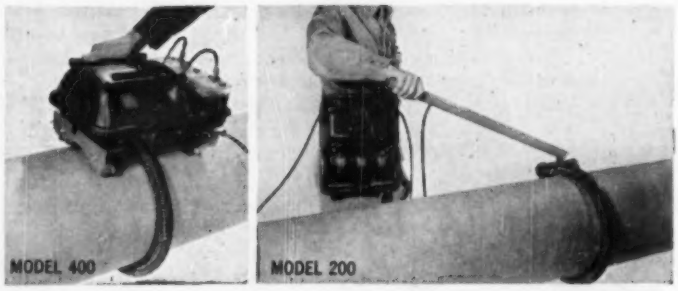

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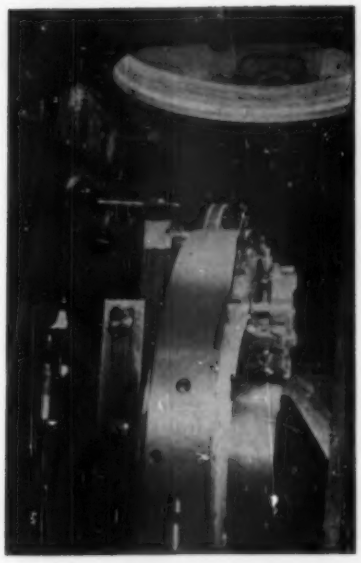

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Worn and damaged flywheel fits refinished in place.

In our shop crankshafts of any size or type completely refinished. Shafts straightened and broken shafts successfully repaired.

Most modern methods used in rebabbitting and machining engine and turbine bearings.

All types of heavy power plant equipment serviced with special attention given to emergency repairs.

Additional information furnished without obligation.

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SHERMAN, TEXAS
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under the supervision of B. P. Beard. Is working for O. R. Burden Construction Corporation on 183 miles of 24-in. between Brenham and Fort Worth, with Johnny Utsey supervising at Brenham and R. H. Buchanan supervising at Waco.

● **Joyce Pipe Line Company and Joyce Western Corporation, Box E, Andover, New York.** Is constructing for *Peoples Natural Gas Company* 9 miles of 20-in. pipeline between Bridgeville and Imperial, Pennsylvania, under the supervision of L. Ostrander; and is cleaning 27 miles of 20-in. for the same company. Has been awarded contract by *Equitable Gas Company* to construct 4 miles of 20-in. pipeline in the Greene County, Pennsylvania, area and 18 miles of 16-in. in Monongalia and Marion counties, West Virginia, both under the supervision of C. Joyce. C. Joyce also is supervising the construction of 35 miles of 20 and 24-in. pipeline for *Manufacturers Light and Heat Company* in the vicinity of Allegheny County, Pennsylvania.

● **M. L. Moore Construction Company, Box 1444, Odessa, Texas.** Has received a contract from the *Texas Pipe Line Company* to construct a 42-mile, 6-in. products pipeline from the New Hope plant in Franklin County, Texas, to the Nettleton station.

● **Pipe Line Technologists, Inc., 3431 Alabama, Houston, Texas.** Has a contract to construct for *Seadrift Pipeline Corporation* a 108-mile products line from Union Carbide Corporation's Seadrift, Texas, plant to Humble Oil & Refining Company's King Ranch plant at Ella, Texas.

● **Turriff-Burden, Ltd., (subs. Burden International, Ltd., Box 5216, Tulsa, Oklahoma).** Has been awarded a contract by the *Iraq Petroleum Company, Ltd.*, for the construction of 315 miles of 30 and 32-in. pipeline from Kirkuk to the Syrian border and connecting Rumaila and Fao. The project office in London, England, will be managed by W. T. Barker. Field construction superintendent is John H. Miller; assistant superintendent is Arnold Smith; and manager of the field office in Baiji, Iraq, is G. E. Suagee.

● **Williams Brothers Company, National Bank of Tulsa Bldg., Tulsa, Oklahoma.** Has been awarded a contract by the *National Iranian Oil Company* to construct a 240-mile, 8-in. petroleum products line in Iran from Rey, near Tehran, northeast to Sharud. Is laying a pipeline for *Mid-America Pipe Line Company* as follows: Spread No. 1, under Harland Evans, located at Pampa, Texas, will lay approximately 238 miles of 8 and 10-in. pipe in Texas, Oklahoma, and Kansas; Spread No. 2, under Tommy Thompson, located at Arlington, Kansas, will lay approximately 435 miles of 8 and 10-in. pipe in Kansas, Nebraska, and Iowa. Has been awarded a contract by *The Manufacturers Light and Heat Company* to lay 70 miles of 20-in. pipeline from Abbotstown to Warfordsburg, Pennsylvania. Gettysburg is field office site, and Thelmer Davis is superintendent. Has been awarded a contract by *Atlantic Seaboard Corporation* to lay 45 miles of 20-in. pipeline from Terra Alta to Seneca station in West Virginia, with Earl Saulsman supervising.

● **H. B. Zachry Company, Box 10188, San Antonio 21, Texas.** Has been awarded a joint contract with O. R. Burden Construction Corporation to construct *Old Ocean Fuel Company's* 370-mile natural gas pipeline between the Gulf Coast area, south of Houston, Texas, to the Fort Worth area.

FLEET-LINE®
WELDING FITTINGS

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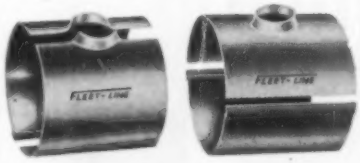
REDUCERS: Concentric and eccentric. Nominal pipe sizes 1" to 30", ASA B16.9, ASTM A234. Schedules 10 to 160, stainless steel, and other alloys. Special lengths and sizes.

SADDLES: Conventional, and for pressure vessel heads. Nozzle sizes from ¼" to 24". Fleet-Line saddles weld neatly into place in much less time, and with much less welding rod.

Full encirclement saddles.



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Dealers and Stocking Distributors throughout the United States and Canada.

All orders acknowledged by air mail or long distance telephone and filled at once.

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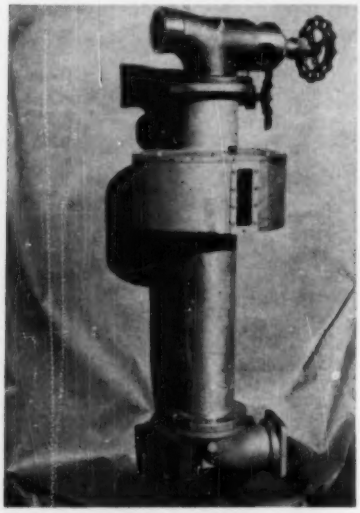
It's New | Pipeline Equipment

New Principle In Flow Measurement

A unique flow meter has been introduced that is said to be ideal for practically any air flow or liquid flow measuring



requirement because it can be made in small or large capacity units, will measure air or liquid flows to nearly any limit at pressures up to 5000 psi, and can be constructed from nearly any metal—also glass, glass fiber, or plastic—to handle practically any conditions of temperature or corrosion. It has a revolving drum-type dial 25 in. in circumference. The circular dial's long calibration range, plus dampening by paddles turning in oil, provide direct "deadbeat" readings at any point throughout the circumference of the dial. The dial is actuated by a turbine wheel attached to a spring wire stretched within a vertical duct. As flow velocity rotates the turbine wheel, the torque created is opposed by the spring of the wire, thus registering the rate of flow on the circular calibrated dial. For extremely wide ranges of flow velocity, it is necessary to use more than one unit. *Highland Engineering Co.*

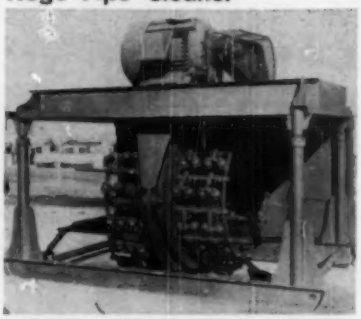
Circle number (81) on reply card.

Reads Out Both Temperature, Pressure

A new digital temperature and pressure readout system has been introduced that will not only monitor from as many as 99 different points but is capable also of remote interrogation because information is encoded for telemetering. The system reads out from resistance temperature bulbs up to 1400 F and from resistance pressure transducers ranging to 10,000 psi. The system uses copper wiring to transducers in lieu of thermocouple wiring. *Texas Instruments, Inc.*

Circle number (82) on reply card.

Huge Pipe Cleaner



Capable of cleaning 24 through 42-in. pipe and weighing 20,000 lb, this is believed to be the largest mechanical pipe cleaning machine ever manufactured. It is 8 ft, 9 in. wide; 9 ft high (not including motor housing); and 9 ft, 4 in. long. Cleaning is performed by Remco Rotary Cup Cleaning Brushes, held at an angle to the pipe and counter rotating. Motor is a 75-hp electric V-belt drive that permits operator to control the speed of the cleaning operation. *Remco Manufacturing Co.*

Circle number (83) on reply card.

High Powered Pocket Receiver Developed

A new 10-ounce "Handie-Talkie" transistorized VHF receiver that can be worn in a pocket or clipped to the belt is now available, providing 500 milliwatts audio output for operation in the standard 2-way mobile radio channels. It has a built-in antenna and a jack for external antenna connection. A trouser-leg antenna

NEW N P

WmSON "PIG-SIG II"

CAN BE INSTALLED OR REMOVED UNDER PRESSURE!

PATENT APPLIED FOR

CUTAWAY VIEW OF PIPELINE

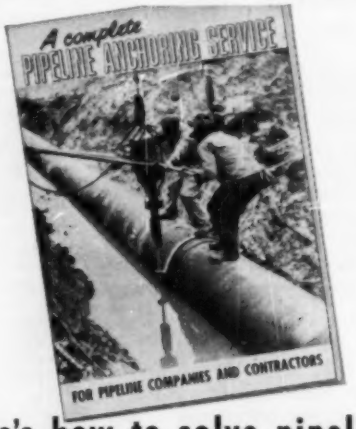
Gives visual or electrical indication of pig passage. Pig-Sig II with electrical indicator signals pump station operator or starts operation of automatic equipment. For other applications and complete details write for bulletin A-199.

Write Dept. B-2

T.D. Williamson, Inc.

P. O. BOX 40 TULSA 2, OKLAHOMA

REPRESENTATIVES AROUND THE WORLD



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is available, as well as a helmet mounting type. The pocket unit operates from either a rechargeable battery providing up to 12½ hr operation with each charge, or from replaceable mercury cells that last up to 125 working hours. One type of nickel cadmium charger is available for use on batteries removed from the receiver case. The other type is a rack into which the complete receiver is easily slipped. Connections are made automatically. *Motorola, Inc.*

Circle number (84) on reply card.

New Engines For Pumping Operations

Three new 6-cylinder carbureted engines that feature downdraft carburetion with velocity governor have been introduced to provide power for all types of pumping operations and blowers. Designated the UR-372, UR-450, and UR-501, the engines have the following maximum horsepower ratings respectively: 165 at 3200 rpm; 182 at 3000 rpm, and 212 at 3000 rpm. *International Harvester Co.*

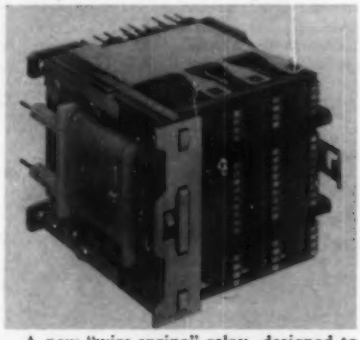
Circle number (85) on reply card.

New Holiday Detector Works in Any Climate

Weather or ground conditions will not affect successful operation of a new pipeline holiday detector. Performing equally well on wet or dry coatings, the fully portable Model HP requires no generator. It makes use of a new electrical field device consisting of a double electrode or plastic coated saddle. This flexible pad is attached directly to the instrument carrier and creates a constant inspection voltage that is adjustable from 5 kv to 20,000. Every inch of the pipe surface is traversed during inspection by spring electrodes, with snap-off connectors for passing over skids. *Tinker & Rasor.*

Circle number (86) on reply card.

Unique Control Component



A new "wire-spring" relay, designed to transfer up to 51 circuits quickly for 100,000,000 or more operations without readjustment, has been developed. It is said to be the first industrial control component of its kind engineered to make or break this large a number of circuits at the same time. A unique actuating card—activated by armature movement—operates all moving wire-spring contacts simultaneously and independently. The WQA series is available in 1, 2, or 3 levels of contact assemblies, with up to 17 Form C combinations, each. Operating voltages range from 6 to 220 d-c. Rectified a-c is also accommodated. The largest contact pile-up (51) requires less than 4 w operating power. Special features include impregnated coil and fungicidal treatment. *Automatic Electric Laboratories, subsidiary of General Telephone & Electronics.*

Circle number (87) on reply card.

FREE report tells how to speed up pump-station maintenance

How to speed up maintenance of pumping stations is told in this specially prepared technical service report.

It's full of performance-proved ideas on how to expedite maintenance cleaning operations...how to put a deep cut in maintenance overhead. In it you'll find valuable shortcuts on:

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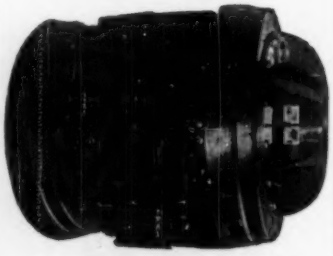

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It's New | Pipeline Literature

First Lit Released On Jet-Driven Gas Turbine

The first literature published on the new 10,500-hp, RT-248 gas turbine is now available. The new 8-page brochure reviews the development of this new power concept, discusses thermal efficiencies, maintenance costs, and potential applications, and devotes 3 pages to schematic drawings, performance curves, and engineering data. The unit's gas generator section is built by Pratt & Whitney Aircraft, based on the J-57 jet engine. *The Cooper-Bessemer Corp.*

Circle number (88) on reply card.

Hardsurfacing Guide

"Manual Hardsurfacing" is a new bulletin that discusses the economics and metallurgy of hardsurfacing, analyzes the various conditions which demand surfacing, and provides information concerning electrode selection and procedures which will produce the type of surfacing desired. *The Lincoln Electric Co.*

Circle number (89) on reply card.

Cat Maps Answers To Equipment Problems

For pipeliners seeking answers to major equipment problems — answers dealing with power, capacity, versatility, ground clearance, operator's conveniences, and job efficiency — is a new 8-page, 2-color booklet entitled "Caterpillar Maps the Answers." *Caterpillar Tractor Co.*

Circle number (90) on reply card.

Protective Coatings

Particularly suitable for application on buried or immersed steel and concrete is Allied's expanded cold-applied coal-tar coatings line, formerly marketed under the name Barrett, now described in a new 13-page, illustrated booklet. Specifications, resistance properties, and typical uses are detailed. *Plastics and Coal Chemicals Div., Allied Chemical Corp.*

Circle number (91) on reply card.

Productive Capacity, Service Life Told

The maintenance-designed Euclid C-6 ... in the 200-hp tractor class ... for heavy dozing and ripping, push-loading big scrapers, pulling heavy loads, stripping, land clearing, or handling stockpile assignments ... is the subject of 2 new brochures. Converter, transmission, steering brakes and clutches assembly can be removed as a complete "package" without major disassembly. It features full power shifting and time-saving maneuverability, the bulletins point out. *Euclid Div., General Motors.*

Circle number (92) on reply card.

Seal Handbook

A design and data handbook on Viton O-Rings as high temperature seals has been published that contains test information on some 150 fluids and gases to which Viton O-Rings are compatible, as well as design techniques, and general information on compounds and dimensions. The 24-pager is a supplement to the Parker O-Ring Handbook No. 5700, a manual on O-Rings. *Parker Seal Co.*

Circle number (93) on reply card.

Introduces 2-Cycle, Turbocharged Gas Engine

A new 2-cycle, V-type, turbocharged gas engine designed as a compact, high horsepower driver for centrifugal pipeline compressors, generators, and liquid pumps is the subject of a new bulletin. Fully described and illustrated are the design features and operating advantages of Clark's Model TPV, which result from joining 2-cycle simplicity and dependability with V-engine compactness. *Clark Bros. Co., one of the Dresser Industries.*

Circle number (94) on reply card.

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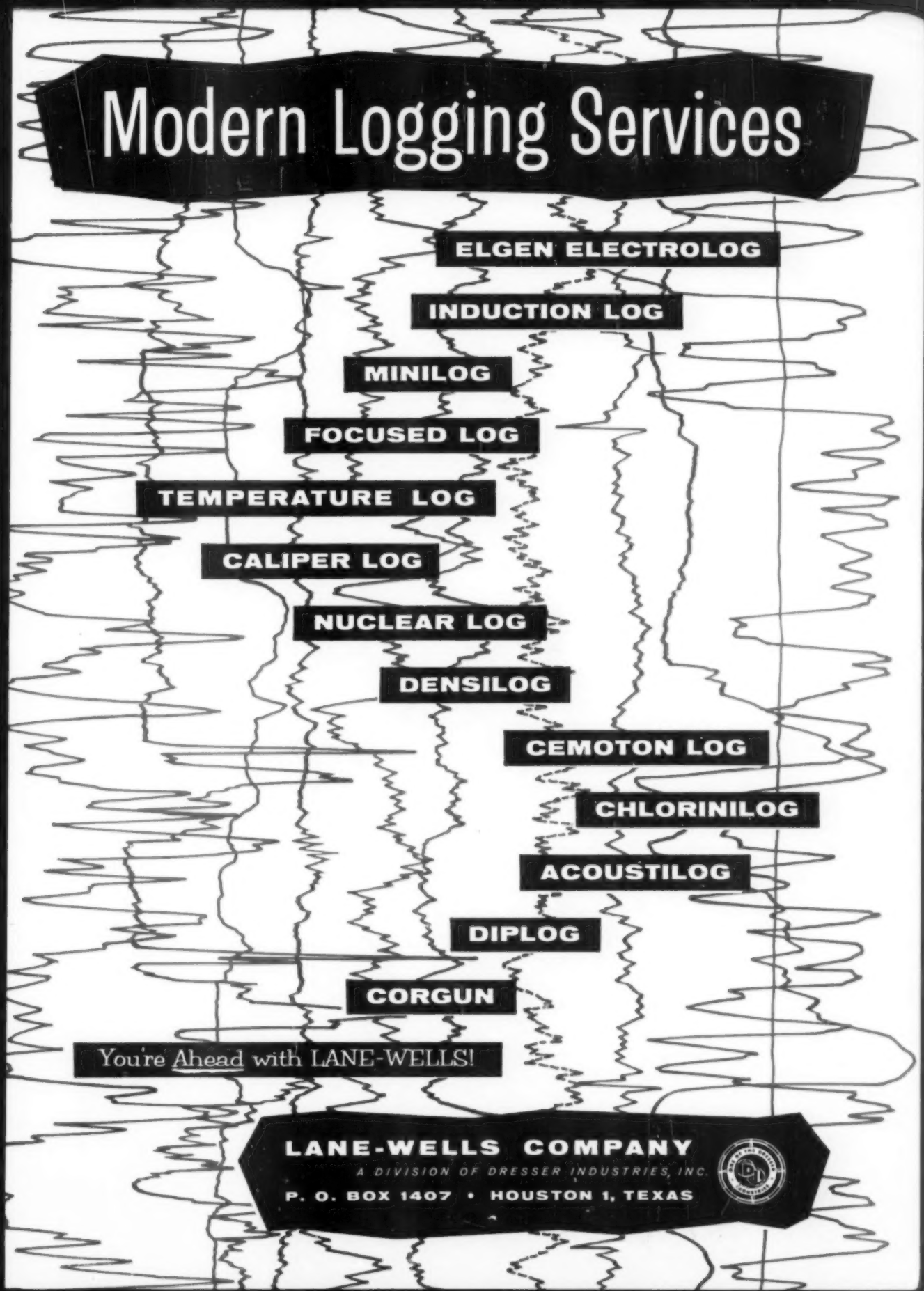
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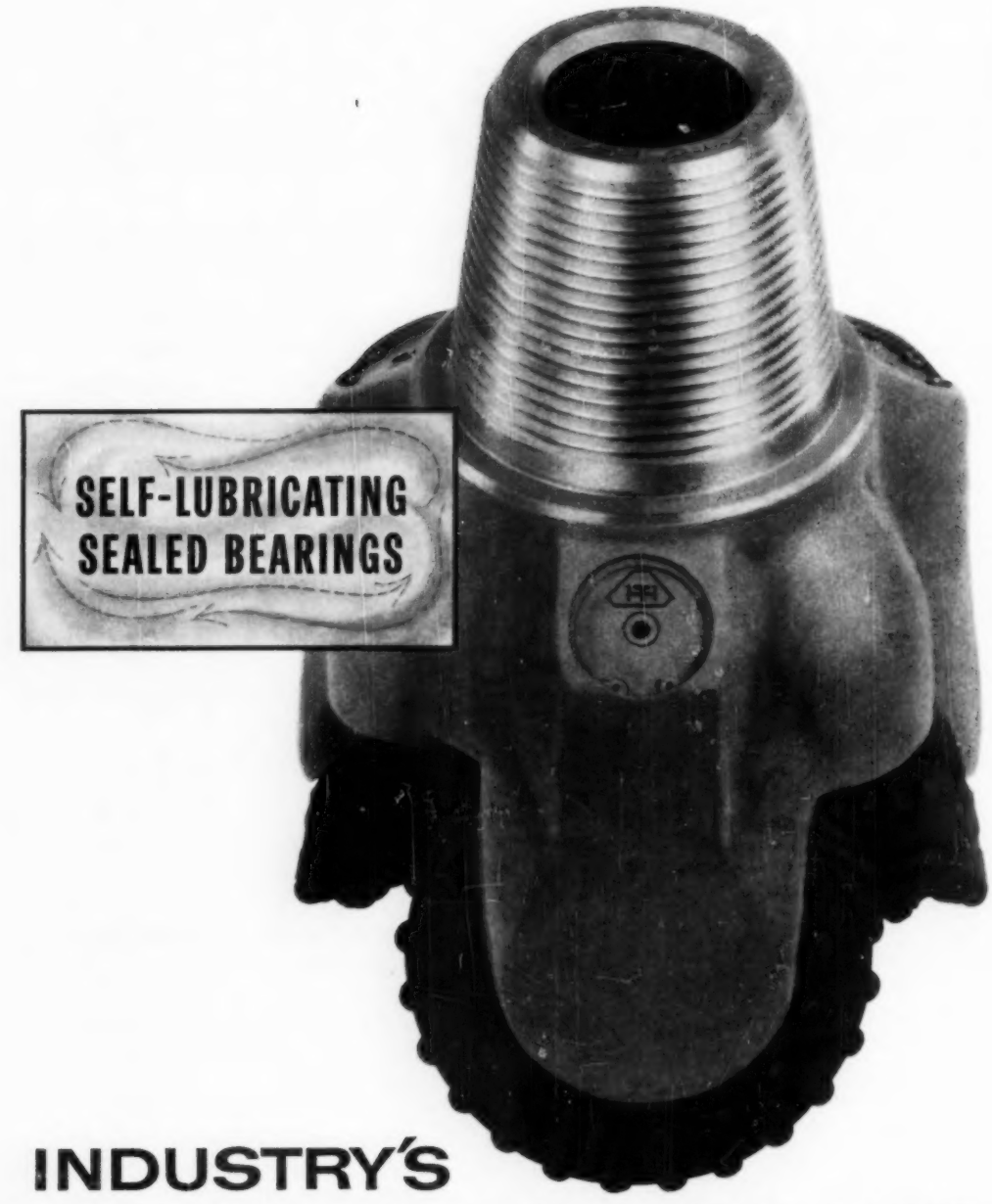

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A new kind of Hughes bit – the *self-lubricating* sealed bearing bit – is rolling off the production line. It represents a major design breakthrough in an era of outstanding rock bit research achievements.

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